# SCIENCE EDUCATION

NARST NUMBER



VOLUME 39 APRIL, 1955 NUMBER 3

# SCIENCE EDUCATION

THE OFFICIAL ORGAN OF

*The National Association for Research in Science Teaching*
*The National Council on Elementary Science*
*Association on the Education of Teachers in Science*

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*Manuscripts and books for review as well as all communications regarding advertising and subscriptions should be sent to the Editor.*

SCIENCE EDUCATION: Published in February, March, April, October, and December.

Subscriptions $5.00 a year; foreign, $6.00. Single copies $1.50; $2.00 in foreign countries. Prices on back numbers furnished upon request.

Publication Office: 374 Broadway, Albany, New York.

Entered as second-class matter at the Post Office at Albany, New York, February 13, 1939, under the Act of March 3, 1879.

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KENNETH E. ANDERSON

# KENNETH E. ANDERSON

DR. KENNETH E. ANDERSON, Dean of the School of Education, University of Kansas, Lawrence, Kansas, was elected twenty-second president of the National Association for Research in Science Teaching at the twenty-seventh annual meeting in Chicago, Illinois. He will preside at the New York City meeting at Teachers College on April 18–20. He succeeds Professor George Greisen Mallinson of Western Michigan College of Education, Kalamazoo, Michigan.

Dean Anderson was born in Minneapolis, Minnesota, March 2, 1910. He married Dorothy Smith of Chisholm, Minnesota. They have two boys—Peter Alden and Philip Norman.

Dean Anderson is a graduate of Central High School, Minneapolis, Minnesota. He has B.S. (1932), M.A. (1934), and Ph.D. (1949) degrees from the University of Minnesota. His Master's thesis is entitled *An Analysis of Periodicals for Curriculum Purposes in Science* and his doctoral dissertation *The Relative Achievements of the Objectives of Secondary School Science in a Representative Sampling of Fifty-six Minnesota High Schools.*

Teaching experience includes:

1. High School Principal, Science, Basketball Coach, Lake Bronson, Minnesota, 1934–36
2. High School Principal, Science, Assistant Coach, New Prague, Minnesota, 1936–38
3. Junior-Senior High School Principal, Science, Hockey Coach, Tracy, Minnesota, 1938–42
4. Superintendent of Schools, Science, Coach, Askov, Minnesota, 1942–44
5. Head of Science Department, Football and Basketball Coach, University High School, University of Minnesota, 1944–45
6. Assistant Director, University High School, 1945–46
7. Director of University High School, 1946–47
8. Principal of the Campus High School, State Teachers College, Cedar Falls, Iowa, 1947–48
9. Assistant Professor of Education, University of Kansas, Lawrence, Kansas, 1948–50
10. Associate Professor of Education and Director of the Bureau of Educational Research and Service, University of Kansas, 1950–52
11. Dean of the School of Education and Professor of Education, University of Kansas, since 1952.

Membership in organizations include National Association for Research in Science Teaching, National Science Teachers Association, American Association for the Advancement of Science, National Association of Elementary School Principals, National Association of Secondary School Principals, National Society for the Study of Education, American Education Research Association, National Society for the Study of Education, Phi Delta Kappa, Central Association of Science and Mathematics Teachers, and American Psychological Association. He is a Fellow in the American Association for the Advancement of Science. He has served on the Executive Committee and as Vice President of NARST.

Dean Anderson has had numerous publications relating to education and science education in various outstanding educational publications, nearly forty articles in all. His publications are found in such magazines as *School Science and Mathematics, Clearing House, School Activities, The Science Teacher, Journal of Experimental Education, Minnesota Journal of Education, Science Education, University of Kansas Bulletin of Education, Journal of Educational Research,* and *The Kansas Teacher.* He is the author of a number of publications found in educational bulletins such as *Kansas Studies in Education, State of Iowa Education Department, Musical Therapy,* and *Bulletin of the Department of Elementary School Principals.* He is co-author of *The Educational Achievement of Indian Children* published by the Bureau of Indian Affairs, Department of Interior. Many science teachers recall and have used

his *Minnesota State Board Examinations in High School Biology and Chemistry, 1947, 1948,* and *1949* and the *Anderson Chemistry Tests Forms A and B* published by the World Book Company. Dean Anderson served as Editor of the *University of Kansas Bulletin of Education* 1950–52 and as its Executive Editor 1953–54. He also served as Executive Editor of *Kansas Studies in Education,* 1952–54. Since 1950, he has served as consultant on testing and research to the Bureau of Indian Affairs. He is also Director of the Institute for Research in the Education of Exceptional Children in Kansas.

One of Dean Anderson's recent major activities and contribution was serving as director of the First Annual Review of Research in Science Education, published in the February, 1954 issue of *Science Education.* In addition to his numerous and varied activities as Dean of the School of Education, Dr. Anderson is directing five research projects in education involving a special appropriation of some $15,000.

Dean Anderson continues the notable list of science educators who have served as President of the National Association for Research in Science Teaching. For many years, Dean Anderson has been one of the most active leaders in science education research and presently is probably the most active. His research studies and the many he directs, are noted for their objectivity as tested by the latest and most rigid statistical techniques. Probably no member of NARST better typifies *research* in National Association for Research in Science Teaching than does its present President.

# AN ANALYSIS OF PRINCIPLES AND ACTIVITIES OF IMPORTANCE FOR GENERAL BIOLOGY COURSES IN HIGH SCHOOLS *†

Margaret J McKibben

*Oak Park and River Forest High School, Oak Park, Illinois*

## PART I

In the last quarter of a century principles of science have gained wide acceptance as objectives of education. There is support for this point of view in the results of learning studies and in the reports of influential committees. As a consequence, numerous research studies dealing completely or in part with principles of science as objectives of education have been made.

Two of these investigations are relevant to the present study. The first, by Martin,[1] was designed to develop a list of principles of biological science and to evaluate them on the basis of their importance for general education. The second, by Miles,[2] dealing with principles and experiments for integrated physical science courses at the high school level, is of importance because it suggests appropriate methods for the present study.

* Paper presented at the twenty-seventh annual meeting of the National Association for Research in Science Teaching, Hotel Sherman, Chicago, Illinois, March 30, 1954. Based on the author's dissertation, completed in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Pittsburgh, January, 1953.

† Dissertation published in Microfilm form by University Microfilms, Ann Arbor, Michigan.

[1] Martin, W. Edgar, "A Determination of the Principles of the Biological Sciences of Importance for General Education," *Science Education,* 29:100–105, March, 1945; 152–63, April-May, 1945.

[2] Miles, Vaden W., "A Determination of Principles and Experiments for an Integrated Course of Physical Science for High School," *Science Education,* 33:147–152, March, 1949; 198–205, April, 1949.

## STATEMENT OF THE PROBLEM AND DEFINITION OF TERMS

The purpose of the first part of the investigation was to evaluate principles of biological science for general biology courses in high schools. By "general biology" is meant a course in biology usually offered in the ninth or tenth grade which is intended to meet the needs of high school pupils regardless of whether they are preparing for college. The definition of the term "principle" developed by Martin is used.

1. It must be a comprehensive generalization which resumes the widest possible range of facts within the domain of facts with which it is directly concerned. The facts resumed in the generalization must denote:
   a. Objects and/or events and the relations between them.
   b. Properties.
2. It must be scientifically true. To satisfy this criterion:
   a. It must be verifiable; *i.e.*, it must be stated so that it suggests, either directly or indirectly, a definite operation of observation or experiment whereby its truth can be tested or verified.
   b. It must be consistent with the body of accepted scientific knowledge, and except for a few limiting or singular exceptions, with all the data (facts) relevant to it.[3]

## METHODS

The evaluation of principles for use in high school biology courses involved three sub-problems. The first was the selection of a qualified jury; the second, the construction of a checklist containing directions for evaluation of a list of principles of biological science for use at the high school level; and the third, the tabulation of the evaluations of the jury.

The opinions of science education specialists and qualified high school biology teachers concerning the importance of principles for high school biology courses were assumed to be a valid basis for the evaluation of principles. Names of specialists in the teaching of high school biology for the jury were taken from the membership list of the National Association for Research in Science Teaching. Names of classroom teachers for this purpose were secured by an analysis of issues of periodicals in the field of science education covering a ten year period. Those who had written articles with a general education point of view on an aspect of the teaching of high school biology were considered qualified to evaluate principles of biological science for use in general biology courses in high schools. Thirteen specialists and 19 classroom teachers, or 65 per cent of those who were asked to cooperate in this part of the study, returned completed checklists.

The Ten Imperative Needs of Youth are a recent and authoritative statement of the objectives of secondary education. They were thought to be appropriate criteria for evaluation of principles of biological science for high school courses. A checklist containing statements of these needs in abbreviated form and the list of 300 principles of biological science developed by Martin were sent to members of the jury. Directions for completion of the checklist asked the correspondent to indicate, whether, in his opinion, each principle was essential, desirable or undesirable for use in high school biology courses on the basis of how well it met the criteria employed.

Two complete tabulations of the returns thus secured were made by the investigator and an assistant. If an item in the second tabulation did not agree with the corresponding item in the first, the tabulation for that item was performed a third time. In this way errors were detected and eliminated.

In tabulation, evaluations as essential, desirable and undesirable were arbitrarily assigned values of +3, +2 and −2 respectively. The total numerical value of the sum of the evaluations of a principle was assumed to indicate its value for gen-

[3] Martin, *op. cit.*, p. 101.

eral education in high school biology courses.

The 100 principles receiving the highest evaluations by the combined juries for inclusion in biology courses in high schools are arranged in descending order of importance for such courses in Table I. The numeral in the second column is the total positive evaluation of a principle by the combined juries. The numeral in the first column indicates its rank according to this evaluation.

TABLE I

ONE HUNDRED PRINCIPLES OF BIOLOGICAL SCIENCE OF GREATEST IMPORTANCE FOR GENERAL EDUCATION IN HIGH SCHOOL BIOLOGY COURSES

| Rank | Total Positive Evaluation | |
|---|---|---|
| 1 | 95 | Reproduction is a fundamental biological process that provides for the continuance of life on the earth by providing new individuals. |
| 2 | 94 | Carbon dioxide set free during the respiration of both plants and animals is absorbed by plants and used as a raw material of photosynthesis. |
| 4 | 93 | Protoplasm is built only by protoplasm and every cell comes from a cell. |
| 4 | 93 | Starches, fats and proteins are produced by plants and it is upon these that all animals depend primarily for food. |
| 4 | 93 | All living things respond to stimuli in their environment. |
| 9 | 92 | There is a cycle, from inorganic substances in the air and soil to plant tissue, thence to animal tissue, from either of the last two stages via excretion or death and decay back to the air and soil. The energy for this everlasting rotation of life is furnished by the radiant energy of the sun. |
| 9 | 92 | Protoplasm is the physical basis of all life. |
| 9 | 92 | The fundamental life processes are the same in all organisms. |
| 9 | 92 | The work of the chlorophyll of all chlorophyll-bearing plants is essential to all living things. |
| 9 | 92 | The cell is the unit of structure and function in all organisms. |
| 9 | 92 | Heredity supplies the native capacities of an organism; environment determines to a large extent how fully these capacities will be developed. |
| 9 | 92 | In the presence of sunlight the chloroplasts of chlorophyll-bearing plants convert carbon dioxide and water into intermediate substances, and these into sugar, and sugar into starch, and liberate oxygen; thus directly or indirectly producing practically all the food in the world. |
| 14 | 91 | All embryos start from a single fertilized egg cell and grow through division and redivision into the form of the organism which produces the egg cell. |
| 14 | 91 | All life comes from preceding life. |
| 14 | 91 | The energy which makes possible the activity of most living things comes at first from the sun and is secured by the organism through the oxidation of food within its body. |
| 17 | 90 | The smallest unit of living material capable of existing independently and of maintaining itself is the unit called the cell. |
| 17 | 90 | Food, oxygen, certain optimal conditions of temperature, moisture, and light are essential to the life of most living things. |
| 17 | 90 | All communicable diseases are caused by microorganisms. |
| 19.5 | 89 | Enzymes, vitamins, and hormones are chemical regulators (stimulators and suppressors) of the reactions that occur in living organisms. |
| 19.5 | 89 | For each disease caused by an organism a specific microbe exists. |
| 23.5 | 88 | Throughout the life of every organism there is a building up and a tearing down of protoplasm with constant transformations of energy. |
| 23.5 | 88 | Growth and repair are fundamental activities for all protoplasm. |
| 23.5 | 88 | Digestion accomplishes two things: it makes food soluble in water, thus enabling the nutrients to pass through membranes and thereby reach and enter the cells; it reduces complex nutrients (fats, proteins, and carbohydrates) to simple building materials which in turn can be rebuilt into whatever living material or structural feature is necessary at the place of use. |

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| 23.5 | 88 | Water is essential to all living things because protoplasmic activity is dependent upon an adequate water supply. |
| 23.5 | 88 | A balance in nature is maintained through interrelations of plants and animals with each other and with their physical environment. |
| 23.5 | 88 | Infection by microorganisms is possible only under the following conditions: 1. The infecting organism must enter the host in sufficient numbers; 2. It must enter by an appropriate avenue; 3. It must be virulent; 4. The host must be receptive. |
| 31 | 87 | Cells are organized into tissues, tissues into organs and organs into systems, the better to carry on the functions of complex organisms. |
| 31 | 87 | The food requirements of every living thing are: fuels capable of yielding, when oxidized, the supply of energy without which life cannot continue; materials for growth and for replacement for the slight wearing away of the living tissue involved in any activity; minerals, the necessary constituents of cell structure, of cell products, and of the bathing fluid of cells; the vitamins of "accessory" food factors. |
| 31 | 87 | All sexually reproduced individuals begin their careers as single fertilized cells. |
| 31 | 87 | In sexual reproduction a male cell from one parent unites with a female cell from the other parent to produce the young (except in the few cases of self-fertilization). |
| 31 | 87 | The hereditary characteristics possessed by any organism depend wholly upon the genes that were transmitted to it in the reproductive cells received from its parents. |
| 31 | 87 | New kinds of living things have arisen through mutation. |
| 31 | 87 | The environment acts upon living things, and living things act upon their environment. |
| 31 | 87 | The environment of living things changes continually. |
| 31 | 87 | Fossils, dated by the rocks in which they are found reveal portions of the actual story of life's past changes by a progression of forms from simple to complex. |
| 38 | 86 | Cell division is the essential mechanism of reproduction, of heredity, and to a large extent, of organic evolution. |
| 38 | 86 | An organism must have certain materials for its life processes and each organism must secure the required materials that it cannot build for itself. |
| 38 | 86 | The protoplasm of a cell carries on continuously all the general processes of any living body; the processes concerned in the growth and repair of upbuilding of protoplasm (anabolism) and the processes concerned with the breaking down of protoplasm and elimination of wastes from the cell (catabolism). The sum of all these chemical and physical processes is metabolism. |
| 38 | 86 | The genes of all organisms are subject to change, such changes producing heritable modifications in organisms called mutations. |
| 38 | 86 | The organisms most likely to survive and reproduce are those that are structurally and physiologically best fitted to their environments. |
| 44.5 | 85 | All living organisms (except viruses and bacteriophage) carry on the common life processes; reproduction, growth, nutrition, excretion, respiration, and irritability. |
| 44.5 | 85 | The respiratory process of both plants and animals involves exactly the same gaseous exchange and accomplishes the same function—the release of energy. |
| 44.5 | 85 | Circulation is carried on in all living organisms. With increase in size and complexity of the body of an organism there goes a corresponding elaboration of the transportation (circulatory) system. |
| 44.5 | 85 | All the modes of reproduction of organic life are alike in their nature, varying only in complexity of development; they fall into two general categories, asexual and sexual reproduction. |
| 44.5 | 85 | Living things come only from living things. |
| 44.5 | 85 | The hereditary characters in all organisms are determined by the genes which are carried in the chromosomes. |
| 44.5 | 85 | All living things are continually engaged in an exacting struggle with their environments. |
| 44.5 | 85 | The oxygen of the atmosphere is removed by animals and returned by chlorophyll-bearing plants. |
| 51 | 84 | The nucleus of a cell always contains a complex of protein materials, chromatin, the specialized vehicle which transmits hereditary characters in organisms. |

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| 51 | 84 | An animal cannot live without proteins. They are necessary in cell growth and maintenance; so are necessities in the diets of animals. Plants are able to use carbohydrates and nitrates to build up the proteins necessary for growth and maintenance of their cells. |
| 51 | 84 | Digestion in plants and animals is carried on by enzymes, or organic catalysts, which are made by the organisms themselves and which take part in and speed up the chemical reactions but do not undergo any permanent chemical change themselves. |
| 51 | 84 | Oxygen free in the atmosphere or dissolved in water supplies the respiratory needs of practically all living organisms, except for a few parasitic and anaerobic animals, and a number of bacteria and fungi which can extract the oxygen needed for their energy production from the organic substances on which they feed. |
| 51 | 84 | Acquired characters are not inherited. |
| 54.5 | 83 | The genes in the chromosomes of the egg and the sperm are the carriers of the structural characters of the parents to the next generation. |
| 54.5 | 83 | Only the topsoil, with its rich organic matter, its porous structure, and its living organisms, can hold the water and provide the minerals necessary to the life of most plants. |
| 58.5 | 82 | Every cell consists essentially of a mass of protoplasm which is usually differentiated into a central portion, the nucleus, and an outer portion, the cytoplasm. |
| 58.5 | 82 | The fundamental process of reproduction in all organisms whose cells possess nuclei is cell division which results in the precise distribution of the chromatin of the nucleus. |
| 58.5 | 82 | The carbohydrate foods made by the chloroplasts of chlorophyll-bearing plants are the original source of all energy used by plants themselves (except by the autotrophic bacteria) as well as that used by animals. |
| 58.5 | 82 | In organisms the end products of metabolism, water, carbon dioxide, and nitrogenous compounds, are either stored in the cells as insoluble crystals, are eliminated in solution by diffusion or osmosis (excretion); are incorporated into useful cell products (secretion); or are recombined into food substances within the organism. |
| 58.5 | 82 | Every species of organism is subject to certain checks or controls in the form of enemies and only those members that are most capable of avoiding their enemies survive to reproduce new offspring and thereby transmit many of their characters to their offspring. |
| 58.5 | 82 | Species not fitted to the conditions about them do not thrive and finally become extinct. |
| 65.5 | 81 | All living things, except chemosynthetic bacteria depend directly or indirectly on photosynthesis for food. |
| 65.5 | 81 | Reproduction in all organisms is a process of growth in which a single cell or a group of cells is separated from the parent body and develops into a new individual. |
| 65.5 | 81 | The genes in the chromosomes of eggs and sperms are the physical basis of heredity. |
| 65.5 | 81 | Evolution has needed enormous lapses of time for its operations. |
| 65.5 | 81 | Chlorophyll-bearing plants are adapted for food making. |
| 65.5 | 81 | When the balance of nature is disturbed, disastrous results often follow. |
| 65.5 | 81 | Viruses require living cells for their growth and they multiply only within living cells. |
| 65.5 | 81 | Most cases of fermentation, souring, and putrefaction are brought about by living microorganisms. |
| 74 | 80 | All cells arise through the division of previous cells (or protoplasm), back to the primitive ancestral cell (or protoplasm). |
| 74 | 80 | All living cells require oxygen to provide energy or to build new protoplasm. |
| 74 | 80 | In all organisms, the higher the organization the greater the degree of differentiation and division of labor and of the dependency of one part upon another. |
| 74 | 80 | The existing forms of life on the earth are not all the forms of life which have existed; there has been a great variety of animals and plants which have passed away. |
| 74 | 80 | All living things are slowly changing, both structurally and functionally, in response to changes in their physical environments. |
| 74 | 80 | The surface of the earth and the atmosphere surrounding the earth are |

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| | | undergoing constant changes; therefore, in order to survive, organisms must migrate, hibernate, aestivate, build artificial shelters, or otherwise become adapted to these changes. |
| 74 | 80 | All plants and animals are engaged in a constant struggle for energy. |
| 74 | 80 | All the higher forms of terrestrial life are dependent either directly or indirectly on the soil bacteria for their nitrogen supply. |
| 74 | 80 | Plants and animals are directly or indirectly dependent on the soil. |
| 83 | 79 | All living organisms have other living things which compete with them for the available energy. |
| 83 | 79 | The physical and chemical properties of plant and animal protoplasm are similar. |
| 83 | 79 | Decomposition of the carbon compounds of organisms provides a replenishment of carbon in the atmosphere in the form of carbon dioxide. Thus carbon is continually subjected to a series of cyclic changes from living to non-living substances. |
| 83 | 79 | From the lower to the higher forms of life, there is an increasing complexity of structure, and this is accompanied by a progressive increase in division of labor. |
| 83 | 79 | Plants and animals utilize similar food substances but they are obtained in different ways. |
| 83 | 79 | The continuance of higher forms of life in anything like the present kinds and numbers would be impossible without bacteria and molds. They break down the complex carbohydrate and protein substances of dead plants and animals into simpler substances which may then be used again by living plants. |
| 83 | 79 | All plant and animal life, along with the climate and varying weather, play an active part in helping to form and to change the soil. |
| 83 | 79 | The present is the key to the past; the succession of fossils in the rock shows a progressive series from simple to complex. |
| 83 | 79 | A parasitic organism harms its host in various ways and to various degrees, by actively attacking the tissues, by shedding poisons (toxins) which are distributed throughout the body of the host, by competing with the host for food or even by making reproduction of the host impossible. |
| 89 | 77 | Sexual reproduction is an almost universal method of reproduction and occurs in representatives of every phylum of plants and animals. |
| 89 | 77 | The germ plasm of animals and plants passes on from generation to generation and there has been a continuous stream from the first organism to the present living organisms. |
| 89 | 77 | Certain one-celled organisms escape adverse conditions by forming highly resistant spores which often survive until conditions are again favorable. |
| 92.5 | 76 | Oxidation (combustion) furnishes the essential source of heat in the animal body; and other factors remaining constant, the more heat so produced the warmer the animal body. |
| 92.5 | 76 | Osmosis, the diffusion of molecules of a solvent (usually water) through a semi-permeable membrane (a layer of cells or the membrane of a single cell) from a point of higher concentration of the solvent to a point of lower concentration, with a stoppage of the flow of molecules of the solute, is a basic process in plant and animal physiology. |
| 92.5 | 76 | Plants and animals in the course of their generations are changed and molded to meet the requirements of their existence, and the individuals and types best adapted to their life situations are the ones that survive. |
| 92.5 | 76 | Life, as we know it, is dependent upon complex chemical compounds of carbon, nitrogen, hydrogen, oxygen, and other elements. |
| 96.5 | 75 | Energy and matter are not created or destroyed in the reactions associated with the life processes, but are passed on from organism to organism in endless succession. |
| 96.5 | 75 | The reproductive elements and their union in fertilization are fundamentally the same in plants and animals. |
| 96.5 | 75 | In a living organism, adaptation of action and adaptation of structure are necessary for survival. |
| 96.5 | 75 | In all organisms, increasing complexity of structure is accomplished by an increasing division of labor. |
| 101.5 | 74 | Carbon and nitrogen are the basic elements in the protoplasmic compounds. |
| 101.5 | 74 | Living things reproduce offspring which possess the genes of their ancestors through these offspring do not necessarily resemble any one of these ancestors. |

### FINDINGS

1. A list of 300 principles of biological science arranged in descending order of value for high school biology courses.
2. The rank of each of the 152 principles of biological science of greatest importance for high school biology courses under the heading under which it appeared in Martin's topical outline.

## PART II

### STATEMENT OF THE PROBLEM AND DEFINITION OF TERMS

The purpose of the second part of the investigation was to determine (1) the relative value of activities in contributing to an understanding of principles to which they had been related in the first part of the study for use in high school biology courses and (2) whether each activity would more appropriately be done as a demonstration or as an individual laboratory activity.

The criteria used for selection of activities from textbooks, workbooks and periodical literature in this part of the study may be used to define the term "activity." These criteria are as follows:

1. The procedure must involve manipulation and/or observation of materials.
2. The procedure must not be a test for an element or compound.
3. The procedure must have specific directions for performance.

Activities fall into two categories which were defined as follows by Miles: "A laboratory experiment is one which is pupil-performed for observation by only the performer or performers. A demonstration experiment is one which is performed by the teacher and/or one or more pupils, and is for observation by all members of the class." [4]

[4] Miles, Vaden W., "A Determination of Principles and Experiments for an Integrated Course of Physical Science for High School," *Science Education*, 33:147–152, March, 1949; 198–205, April, 1949.

The second phase of the study was divided into four sub-problems. The first was to assemble activities by an analysis of biology textbooks and workbooks and periodical literature. The next was to assign activities thus secured to those principles to an understanding of which they might reasonably be expected to contribute. The third problem was to construct a checklist containing principles, related activities and directions for evaluation of activities with respect to their contribution as demonstrations or laboratory experiments to an understanding of the principles to which they had been assigned. The final problem was to tabulate the data provided by the checklist returned by a jury chosen as was the one in the first part of the study.

Textbooks, workbooks and periodical literature published during the ten years prior to the beginning of the study were subjected to a careful analysis to secure descriptions of activities. Each activity, stated in question form, was recorded on a filing card. The card was keyed to indicate the source of the activity.

The cards indicating activities were filed according to the topics under which Martin had arranged the 300 principles of biological science developed in his study. A total of 3,200 activities were filed in this manner. Duplicates were eliminated at this point to facilitate the assignment of activities to principles. Six hundred thirty-three different activities remained after elimination of duplicates.

It was felt, since a limited number of principles can be presented in a school year, that no useful purpose would be served by evaluating activities in relation to all of the 300 principles of Martin's list. For this reason, as well as to reduce the size of the checklist, certain principles were omitted from the checklist in its final form.

Several methods were used in excluding principles. It was assumed that those ranking lower than 150 in the list of principles arranged in decreasing order of value

for high school courses were not of great significance for such courses. Furthermore, in certain cases, principles with slightly different emphasis had essentially the same meaning. The investigator felt that, if the meanings of two principles were similar, an understanding of each could be equally well developed by a single activity or set of activities. Here the principle occurring first in the topically arranged list was retained, while the second was omitted. In still other cases, principles were omitted because no activities were found in the sources examined which might be expected to contribute to their understanding.

A subject matter specialist, a senior member of the Department of Biological Sciences of the University of Pittsburgh, checked the judgments of the investigator as to whether a principle should be retained. The faculty member agreed with the investigator in all cases. In its final form, the checklist contained 93 principles and related activities arranged by topic.

In cases in which an activity would contribute to an understanding of more than one principle, the card bearing the activity was filed under the first appropriate principle. Duplicate cards were made and filed under the remaining principles.

A tentative checklist containing the principles and activities assigned to each was typed from this arrangement of cards. The subject matter specialist read it in this form and approved the assignments of activities which had been made by the investigator. A set of directions for completing the checklist was prepared and presented to members of a workshop in science education for criticism and clarification. These instructions, with slight modification, were those developed and used by Miles in his study dealing with principles and activities in the physical sciences.[5]

The evaluator was asked to encircle the letter "N" to the right of each activity if, in his opinion, the activity did not contribute to an understanding of the principle under which it was listed. He was then asked to indicate by encircling the appropriate numeral, whether the activity

1. is not at all suited for a high school course for general education; and for the development of an understanding of the principle to which it has been assigned,
2. is poorly suited,
3. is neither poorly nor well suited,
4. is well suited,
5. is ideally suited for such courses and for the development of an understanding of the principle to which it has been assigned.

Finally, the evaluator was asked to indicate by encircling the letter "D" or "L" whether the activity would more appropriately be done as a demonstration or as an individually performed laboratory experiment.

Because of its length, the checklist was divided into three sections, each to be completed by a different group of specialists and teachers. Fifteen specialists and 15 teachers, or sixty per cent of those asked to cooperate in this part of the study, returned completed checklists.

As before, two tabulations were made to detect and eliminate errors. The tabulation was based on a summation of the algebraic values indicated in the five-point scale. It was assumed that a mean between 4.6 and 5.0 indicated that a majority of the ten evaluators agreed that an activity was *ideally* suited for developing an understanding of the principle to which it had been related and that one between 3.6 and 4.5 was *well* suited for such a purpose.

Table II indicates activities related to a principle of biological science which were judged to be ideally or well suited to contributing to an understanding of it. The preferred method of performance is indicated by the D (demonstration) or L (individual laboratory activity) following the statement of the activity. If both letters occur, the activity would be equally well performed by either method.

[5] *Ibid.*, pp. 202–203.

TABLE II

Activities Ideally or Well Suited to Contribute to an Understanding of a Principle of Biological Science of Importance for High School Biology Courses

Reproduction is a fundamental process that provides for the continuance of life on the earth by providing new individuals.

Does growth occur in pieces of potato containing "eyes"? L
How do molds cultured on damp bread reproduce? L
Do eggs produced by moths and butterflies in the classroom hatch? D
What is the microscopic appearance of the stages of mitosis in prepared slides of onion root tip, whitefish eggs, etc.? D
Can new plants of geraniums, willows, roses, etc. be grown from cuttings? D
What methods of reproduction are found in algae and protozoa? L
How do snails and tropical fish reproduce? D
What is the appearance of a yeast culture immediately after it has been prepared from dry yeast? Several hours later? DL
How do ants observed in an antarium reproduce? D
What methods of reproduction are found in hydra? DL
How do mice, guinea pigs, etc., reproduce? D
Can fern prothallia be grown in damp, upturned flower pots? D
What is the smallest fraction of an earthworm, hydra, or leaf of bryophyllum that will regenerate into a new organism? L
How do birds carry on their reproductive activities? DL

## FINDINGS

1. Five hundred fifty-eight assignments of activities ideally or well suited to developing an understanding of 93 principles of biological science of greatest importance for general education in high school biology courses were made.

2. Sixty-nine or 12.3 per cent of the 558 acceptable activities were ideally suited to contributing to an understanding of the principles to which they were related and 489 or 87.6 per cent were well suited for such purposes.

3. The 93 principles remaining in the list after duplicates were eliminated had an average of six activities which were ideally or well suited to developing an understanding of them and an average of 0.7 which was ideally suited.

4. Thirty-eight principles or 40.9 per cent of the list of 93 had at least one activity assigned which was ideally suited for developing an understanding of them, whereas 55 or 59.1 per cent had none.

5. For 18 or 11.8 per cent of the principles in the list of 152 no activities were found which might reasonably be expected to contribute to their understanding. Moreover, three other principles or 1.9 per cent of this number had no activities which were ideally or well suited for such purposes. Consequently, a total of 21 or 13.8 per cent of the original 152 principles included in the second part of the study had no activities which were acceptable for use in high school biology courses.

6. Two hundred seventy-three or 48.9 per cent of the acceptable activities would more appropriately be performed as demonstrations, 231 or 41.4 per cent as individual laboratory activities and 54 or 9.1 per cent equally well by either method.

## CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations were drawn as the result of an analysis of the findings in parts one and two of the present study:

1. The 152 principles of biological science in Table I constitute a sufficient number from which to select for high school biology courses for general education. The principles in this revised list represent all of Martin's major divisions, thus providing an adequate subject-matter coverage of the biological sciences.

2. There are sufficient activities which are at least well suited to developing understandings of a majority of the important principles of the biological sciences from which to select for high school biology courses.

3. For a few principles no contributory activities were found in textbooks, work-

books and periodical literature. In addition, certain principles did not have activities which were ideally or well suited. It is possible that an understanding of these important principles may be developed by means of such visual aids as slides, film strips and motion pictures. Moreover, an attempt should be made to discover, develop and evaluate activities which contribute to these principles.

4. A slight majority of the activities ideally or well suited to developing understandings of the principles to which they had been related would more appropriately be performed as demonstrations than as individual laboratory activities.

# DETERMINATION OF EARTH SCIENCE PRINCIPLES DESIRABLE FOR INCLUSION IN THE SCIENCE PROGRAM OF GENERAL EDUCATION IN THE SECONDARY SCHOOL *

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## PART I

### EARTH SCIENCE † PRINCIPLES STRENGTHEN THE SCIENCE PROGRAM OF GENERAL EDUCATION IN THE SECONDARY SCHOOL

SCIENCE concepts (principles) of the earth are finding an increasing emphasis in the classroom and in outdoor education in order to build better citizenship for all secondary school students. The purpose of science in the American high school during the last 50 years has slowly changed from an emphasis on preparation for college and training for the specialist toward meeting an ever-increasing demand to prepare youth for living in a scientific culture. The same half-century has been marked by a shift in the high school population from a small selective group to a much larger group that includes most of the secondary school-age group. With this increased enrollment, the high school population has become more heterogeneous. A more diversified pupil population has brought to the high school an increase in the differences of pupil abilities and needs. This condition relative to individual differences among pupils has posed a major problem to instruction. This instructional problem is made more complex by the fact that high school education is terminal education for approximately 80 per cent of the secondary school population.[1]

These conditions pose an urgent and immediate need for curriculum reconstruction in the secondary school offerings. At present, an immediate need for curriculum reconstruction rests upon the secondary school science offerings. This need was expressed by Earl J. McGrath,[2] indicating that the program of science for general education must be such as to make well-rounded and substantial contribution to the aim of general education. This aim in general education is to relate the basic sciences to their social implications. It seems reasonable that the use of earth

* Paper presented at the twenty-seventh annual meeting of the National Association for Research in Science Teaching, Hotel Sherman, Chicago, Illinois, March 30, 1954. Based on a doctoral study under the same title completed at Indiana University, 1953.

† The areas of culture embraced by the term Earth Science include: geology, astronomy, geography, weather and climate, and the scientific aspects of conservation.

[1] U. S. Office of Education, Education for Life Adjustment, *Vitalizing Secondary Education*, Bulletin No. 3, Washington, D. C., 1951, 106 P.

[2] McGrath, E. J., Former U. S. Commissioner of Education, *Science in General Education*, 1948, 366 P.

science concepts in the science program of general education in the secondary school should portray many significant social implications of science.

There is a growing trend toward the use of earth science concepts (principles) as the guides to the selection of materials and to the teaching of science for general education in the secondary school. Early signs toward this trend began in 1932 when the Committee on the Teaching of Science[3] indicated that the science curriculum for general education should be organized about large objectives. These large objectives should be principles which are functional for the individual and enable him to interpret his experiences of living. These principles which ramify most widely into human affairs should be stated as the objectives of this science program.

Previous to this committee report, G. S. Craig in 1927 reported on curriculum developments in the Horace Mann School in New York City, stated the first function of science as the comprehension of principles. Likewise, the 1947 report of the Committee on the Teaching of Science of the National Society for the Study of Education followed in the steps of the 1932 committee in that it submitted a list of objectives for science teaching. Also, Philip G. Johnson in his address before the meeting of the National Education Association in 1938 stated that principles should be emphasized in the teaching of science since they are relatively few in number and because, since they are general, we often meet situations in which they apply. Each application which the child makes of a principle gives it more significance to him, when the facts are forgotten, the principle is still significant because it is a functional law in everyday living. Johnson concluded with the thought that we should emphasize principles in science teaching because they represent the product of inductive and deductive thinking of a higher order.

In order to illustrate what is meant by experiences which lead to an association of ideas and hence to principles, small children observe a stream carrying away earth and are able to see how valleys are cut and hills are formed. As the child grows, his observations, based on the same experiences with small streams, become more discerning and lead to a more complete understanding of the principle that the earth is old in changes brought on by the operations of laws of physics, chemistry, and biology. It may be concluded that, since these principles may be stated as objectives of science teaching, they must occupy an important place in a program of science for general education. Since the aim of science for general education is life enrichment, children should be introduced to big ideas early.

Educational leaders in the secondary schools during the last twenty years have studied the problem of the function of science in the general education program for all secondary school students. Yearbooks and committee reports of various national organizations have considered many aspects of the problem. At least 46 independent research studies have dealt with the same curriculum problem. In 1941, Wise[4] attempted to determine the physical science principles for general education and in 1944, Martin[5] attempted to determine the biological principles of importance in general science. Since 1945, there has been an increasing demand for better understanding of the scientific aspects of the entire earth. This has created a demand during the last eight years for

[3] National Society for the Study of Education, Committee on the Teaching of Science, *A Program of Teaching Science*, 1932, 364 P.

[4] Wise, Harold E., "A Determination of the Relative Importance of Principles of Physical Science for General Education," Unpublished Doctor's dissertation, University of Michigan, 1941. 767 P.

[5] Martin, W. E., "A Determination of the Principles of the Biological Sciences of Importance for General Education," 1944. P. 15. Unpublished Doctor's dissertation, University of Michigan.

an increased emphasis upon the Earth Sciences in the science program of general education in the secondary school. As a result of this growing demand, the author [6] began a study [7] in 1952 which attempted to determine the desirable principles from the earth sciences for the science program of general education in the secondary school.

## PART II

### THE PROBLEM

The purposes of this investigation were: (1) to derive from an analysis of published materials in the earth sciences those principles which may be used in the science program of general education in the secondary school; and (2) to determine the relative importance of earth science principles which are desirable for inclusion in the science program of general education in the secondary school.

### THE METHOD OF INVESTIGATION

This investigation consisted of three phases. The first phase involved the compilation of source materials in the earth sciences. The second phase involved an analysis of selected earth science sources for statements of tentative earth science principles. The third phase involved the determination of the relative importance of earth science principles which are desirable for inclusion in the science program of general education in the secondary school. The relative importance of the earth science principles was determined by a jury of five science educators who have furnished outstanding leadership in the teaching of science.

[6] Caldwell, Loren T., "A Determination of Earth Science Principles Desirable for Inclusion in the Science Program of General Education in the Secondary School," Doctor's Thesis, School of Education, Indiana University, Bloomington, Indiana, 1953.

[7] To secure a brief of this study, please request a copy from Dr. Caldwell at the following address: Dr. Loren T. Caldwell, Acting Head, Earth Science Department, Northern Illinois State Teachers College, DeKalb, Illinois.

In the first phase of this investigation, the assistance of fifty teachers of the earth sciences was solicited as a means of obtaining titles of source materials other than textbooks useful in teaching the earth sciences in the general education curriculum of the secondary school. The selection of these teachers was based on the following criteria:

1. The teachers should be known to be active in national education organizations which are interested in the general education science curriculum of the secondary school.

2. The teachers should be active in promoting an instructional program in the earth sciences in the general education science curriculum of the secondary school.

The fifty teachers who were selected included twenty-five college teachers and twenty-five teachers in secondary schools. Each teacher was supplied with a form and instructions for submitting their suggestions.

In all, 185 different titles were submitted by 35, or 70 per cent, of the 50 teachers. All titles suggested by three or more of these teachers were compiled into a composite list which consisted of 39 different titles.

In order to select those sources of earth science materials other than textbooks which were to be analyzed for earth science principles and supporting earth science applications, four criteria were applied to the composite list of titles that had been compiled as a result of the preceding step. These criteria were as follows:

1. Sources most frequently mentioned by the teachers would be given preference.

2. Sources selected should be written in such a manner as to be comprehensible to pupils in secondary schools.

3. Sources selected should have a publication date from 1938–1952 and must be the latest editions or revisions as of June, 1952.

4. Sources should include materials from

all the four areas of the earth sciences as defined in this investigation.

The application of these criteria resulted in the selection of eight reference books and four bulletins to be analyzed for statements of tentative earth science principles and supporting applications.

In order to obtain a comprehensive list of textbooks related in part or whole to the earth sciences in secondary schools, 34 publishing companies were requested to submit lists of such textbooks. The titles of 30 textbooks including publisher's revisions were obtained by this means.

In order to select those textbooks which were to be analyzed for earth science principles and supporting earth science applications three criteria were applied to the 30 books. These criteria were:

1. The textbooks selected should have a publication date from 1938–1952 and must be the latest editions or revisions as of June, 1952.

2. The textbooks selected should be written in such a manner as to be comprehensible to pupils in secondary schools.

3. The textbooks selected should indicate in the preface or introduction of the book or in the publishers' reviews that they deal with generalized science for the secondary school.

Thirteen textbooks were selected which were judged to satisfy the preceding criteria.

The final step in this first phase of the investigation involved a search for research reports which dealt with the determination of science principles for use in the general education curriculum of the secondary school. This search revealed two doctoral dissertations which dealt in part with earth science principles.

The second phase of this investigation involved an analysis of the earth science sources which were obtained in the first phase of this study. The purpose of this analysis was to secure statements of tentative earth science principles and statements of earth science applications. The following criteria were employed in selecting statements of tentative earth science principles from the sources which were analyzed:

1. The statement must be a comprehensive generalization which summarizes the widest possible range of facts within the domain of facts with which it is directly concerned.

2. The statement must be verifiable; *i.e.*, it must be stated so that it suggests, either directly, or indirectly, some definite operation of observation or experiment whereby its truth can be tested or verified.

3. The statement must be consistent with the body of accepted scientific knowledge and, except for a few limiting or singular exceptions, with all the data (facts) relevant to it. It must be scientifically true.

Statements of earth science applications were also obtained which appeared in the sources as illustrations, demonstrations, experiments, or which described natural phenomena and which served to give meaning and validity to the earth science principle or principles to which they were judged to be related. Each statement of a tentative earth science principle and such statement of a supporting application was placed on a $3'' \times 5''$ index card. In all, 680 tentative earth science principles were selected directly from the source materials and 2,770 statements of supporting applications were obtained.

The next step in this phase of the investigation involved the formulation of tentative earth science principles from statements of supporting earth science applications. First of all, those cards were removed from the file which contained statements of earth science applications. Next the cards were grouped together which contained related statements of applications or which were judged to belong to the same domain of facts. Each of these groups of earth science applications was then employed as the basis for formulating a tentative earth science principle. Finally,

as a test of acceptance of a tentative principle of the earth sciences, the three criteria for identifying earth science principles directly from the sources were applied to each statement that had been formulated by this process, and these were included in a master list of tentative principles of the earth sciences.

The master list of tentative earth science principles was then examined for duplicate statements. Upon removing all duplicate statements, a total of 344 statements of tentative earth science principles remained for use in the next phase of the investigation.

In order to determine the validity of the analysis of source materials an assistant was instructed to analyze fifty pages of source materials which had already been analyzed by this investigator and to select from these sources statements of tentative earth science principles and statements of supporting applications. He was then instructed to formulate tentative earth science principles from supporting applications in the same manner as employed by this investigator. By comparing statements or earth science principles which were obtained by the assistant with those which had been obtained by the investigator himself, the index of validity of the analysis of source materials was found to be 0.89.

The reliability of the analysis of source materials for the earth science principles was judged to be acceptable based upon the judgment of an authority that a validity index of 0.89 was sufficiently high to indicate adequate reliability of the analysis.

In the third and final phase of this study the services of two assistants were obtained for purposes of refining and editing each of the 344 statements of tentative earth science principles. As a result of this procedure there remained 332 refined and edited earth science principles. The list of 332 earth science principles was then submitted to a jury of five science educators for the purpose of determining the relative importance of earth science principles which are desirable for inclusion in the science program of general education in the secondary school. The relative importance rating given to each earth science principle by each jury member was based on the scale of highly desirable (+3), desirable (+2), and undesirable (−2).

Each of the five members of the jury of evaluators rated 34 of the 332 earth science principles as highly desirable for use in the science program of general education in the secondary school curriculum. For purposes of example, the statement of an earth science principle from each of the four areas of geology, physical geography (including weather and climate), astronomy, and the scientific aspects of conservation are given here. Each of these statements received a rating of highly desirable by each of the members of the jury of evaluators.

Statement from the area of geology.

Weathered rock materials are moved toward the ocean in states of suspension and solution by the action of ice, wind, rivers, and shore currents.

This principle gives the teacher an opportunity to gather materials and to present facts and concepts related to the entire program of past and present changes on continents produced by transportational agents of erosion and deposition.

Statement from the area of physical geography (including weather and climate).

Weather phenomena result from temperature and humidity differences which produce winds, clouds, and precipitation types.

This earth science principle gives the teacher the opportunity to gather those materials and to present those ideas which relate the operation of physical laws in the atmosphere to the day by day weather phenomena.

Statement from the area of astronomy.

Our energy all comes directly or indirectly from the sun in the form of heat energy, which produces winds, ocean currents, food, plant and animal tissue, and fuel minerals.

This earth science principle permits the teacher to gather data and present con-

cepts which establish the inter-relationships which exist between our nearest self-luminous astronomical neighbor and our own earth. Thereby, students can have a basis for seeing the energy relationships on a broader scale as they exist in regard to other of the astronomical bodies.

Statement from the area of the scientific aspects of conservation.

Eroding soils lose their mineral, water, and humas content which results in an ever-increasing soil susceptibility to erosion.

This earth science principle gives the teacher an opportunity to furnish materials and information which can lead to the concept that all of the major constituents of a good soil have their maintenance dependent upon the maintenance of the other constituents. This principle of inter-relationship in the realm of the inanimate can be presented in this case to the secondary school student. It may prove to be the more convincing since there is such frequent opportunity in nature to illustrate the principle.

One of the principle advantages which are present in the study of all earth science principles are the frequent opportunities to illustrate the principle and to illustrate its influence upon our immediate and general economic and social pattern of living.

## Summary of Findings

In all, 332 principles of the earth sciences were derived from an analysis of all sources of materials in this investigation. Of these principles, 126 were judged to be related primarily to the area of geology, 75 to the area of physical geography (including weather and climate), 75 to the area of astronomy, and 56 to the area of the scientific aspects of conservation.

Based on the independent ratings of a jury of science educators, 191 principles received algebraic sums from plus 9 to plus 15, 105 principles received algebraic sums from plus 2 to plus 8, and 36 principles received algebraic sums of less than plus 2.

From among the earth science principles which received algebraic sums from plus 2 to plus 15, 123 were related primarily to the area of geology, 60 to physical geography (including weather and climate), 60 to the area of astronomy, and 53 to the area of the scientific aspects of conservation.

Earth Science Principles and Ratings of Relative Desirability for Inclusion in the Science Program of General Education in the Secondary School

| | Relative Importance |
|---|---|
| 1. The earth's fuel minerals are chemical storages of past sunlight, which are now recovered as coal, petroleum, and natural gas | 15* |
| 2. Rocks weather mechanically by differential expansion and contractions, frost actions stress forces, the wedging of plant roots and the burrowing of animals | 15 |
| 3. Weathered rock materials are moved toward the ocean in suspension and solution by the action of wind, running water, ice, and shore currents | 15 |
| 4. The transfer of water between the liquid and gaseous states, is constantly occurring between the atmosphere and the earth's surface | 15 |
| 5. The earth's water supply is essential to life, since it is the fluid vehicle for solution and chemical action | 15 |
| 6. Erosion is accomplished by the turbulent motions of the earth's fluids, which put solid fragments in motion to abrade, to be dissolved, and/or to be suspended for transport | 15 |
| 7. Moving earth fluids carry and sort sediments according to their size, shape, and density with the coarse, dense particles being dropped first | 15 |
| 8. Rivers tend to erode the high land and to deposit sediments in the low places | 15 |
| 9. Water flows from high to low places by the force of gravity in accord with the surface over which it is flowing | 15 |
| 10. The earth's surface has been undergoing constant gradual changes of building up by deposition and internal forces and of tearing down by weathering, erosion, and depression by internal forces | 15 |

* The numerical values are the algebraic sums of the individual evaluations of the five judges on the scale for highly desirable (3), desirable (2), and undesirable (−2).

11. The history of the earth is revealed in the fossil records of life, in the relative positions of rock strata, in the structural deformation of rock strata, in the radioactive delay of minerals, and in the chemical alteration of rock materials..... 15

12. Life on the earth is limited to a zone near the rock and water surfaces which furnish the conditions of temperature, pressure, water, air, and food essential to life.. 15

13. Fossils, dated by the rocks in which they are found, reveal portions of the actual story of life's past changes by a progression of forms from simple to complex ..... 15

14. Land surfaces experience temperature changes more rapidly than do water surfaces, due to the low heat capacity of rocks 15

15. Water is continually being evaporated and/or condensed in the rain cycle, causing a constant exchange of water from place to place ..... 15

16. Air pressure gradients and the rotation of the earth determine the direction and velocity of winds..... 15

17. Weather variations result from changing humidity, pressure, and temperature values of the atmosphere..... 15

18. Weather phenomena result from temperature and humidity differences which produce winds, clouds, and precipitation types ..... 15

19. Diurnal temperature variations result from differences in the length of day and night, and in the angle of the sun's rays to the earth's surfaces..... 15

20. Animals and plants respond in accordance with the nature of the topography with the fertility of the soil, with the amount and quality of the water supply, and with the type of climate..... 15

21. The sun keeps the earth's temperature at values which are favorable for the support of life..... 15

22. Our energy all comes directly or indirectly from the sun in the form of heat energy, winds, ocean currents, food, plant and animal tissue, and fuel minerals..... 15

23. Topsoil supports plant growth and insures the continued support of animal life by plants, which makes its conservation essential ..... 15

24. Soil fertility is maintained and/or established when erosion can be checked and controlled by good land-use practices..... 15

25. Soils vary widely in their natural supply of available plant food which determines the crops to be raised, the minerals to be added, and the land-use plan to be followed in maintaining its fertility..... 15

26. Soil erosion may be controlled by a proper balance of good land-use practices, which may be determined by the land class, the kind of climate, and the type of topography ..... 15

27. Topsoil is eroded when it is exposed to the agents of erosion on unprotected sloping surfaces..... 15

28. Eroded soils lose their mineral, water, and humus content, resulting in an ever increasing soil susceptibility to erosion.... 15

29. The rate of soil erosion is determined by the nature of the weather, the vegetal cover, the soil texture, organic content of the soil, the amount of slope, and the care of the soil..... 15

30. A continuous supply of water from the soil is needed by plants during their growing cycle ..... 15

31. Maintenance of vegetal cover, water retention capacity, control of runoff, and high organic content result from good land-use practices for the control of soil erosion ..... 15

32. The erosion of farmlands can be largely prevented by using crop rotation, contour cropping, strip cropping, and/or terracing as the land may require depending upon its land class, topography, and its climate conditions..... 15

33. Soils support the growth of land plants and these plants furnish food directly or indirectly to animals and humans..... 15

34. Mineral fuels are in limited supply in nature and they are not replaceable, hence there is imperative need for their conservation ..... 15

35. The earth's rock minerals are all derived from molten materials which have solidified and undergone other natural changes ..... 14

36. Surface and subsurface waters carry loads of dissolved minerals from place to place, but generally toward the ocean.... 14

37. Commonly occurring igneous minerals have been modified chemically and mechanically by natural processes to produce the great bulk and variety of common substances found in the earth's crust..... 14

38. Winds, blowing over the earth's water surfaces, cause water waves to form and erode shorelines ..... 14

39. Evaporation rates for water are determined by the water temperature, the air temperature, the air humidity, and the air velocity over the water..... 14

40. The sediments, carried by running water, furnish the tools for erosion..... 14

41. The earth's atmosphere was formed by the action of volcanoes emitting gases and by gas molecules gathered from space by the gravitational pull of the earth..... 14

42. The ground water supply depends upon the amount of surface water seepage into

porous strata and the amount of porous strata ..... 14

43. Fossil records of plant and animal life reveal the evolutionary position of each in the biological history of life on the earth.. 14

44. The older layers of rock contain forms which are extremely unlike the now-living animals and plants while the more recent layers contain types more similar to our contemporary ones ..... 14

45. The degree of exposure of the earth's surface to the sun largely determines the surface temperatures, since rocks are good absorbers of sunlight..... 14

46. Changes in the topography of the earth's surface cause plants and animals to adjust to the new conditions..... 14

47. When water vapor condenses from air, it forms droplets on nuclei which may aggregate to form precipitation types..... 14

48. Rainfall on continents returns to the oceans by means of streams, seepage through the rock strata, and by wind..... 14

49. Wind directions are caused by the relative position of the pressure contrasts and the rotation of the earth which results in spiral wind patterns for air masses.... 14

50. Planetary winds influence the areas into which they flow by giving them their temperature and moisture characteristics.. 14

51. Wind velocities are a result of the pressure gradients producing them, with high pressure gradients producing high-velocity winds and low pressure gradients the reverse ..... 14

52. Dry cool air will settle and moist warm air will be pushed up due to density differences ..... 14

53. Clouds are formed of condensed water vapor consisting of suspended water particles in the air..... 14

54. Air masses transport complete sets of weather conditions, which change as the air masses move over surfaces different from themselves in regard to temperature and moisture ..... 14

55. Air pressure diminishes with increased altitude and with a loss of air density through increased humidity or temperature 14

56. Low and high pressure areas produce contrasting sets of weather conditions such as precipitation with low pressure areas, and clear weather with high pressure areas ..... 14

57. Seasonal temperature differences are produced by the insolation effects of the inclined axis of the earth and the revolution about the sun..... 14

58. Differences in the heat absorption and radiation of the earth's surfaces, air, and water, results in an uneven distribution of heat over the earth..... 14

59. Monthly ranges of temperature vary with the season and with the location, because of differences in the directness of the sun's rays and the absorbing capacity of the surface ..... 14

60. The atmosphere is warmed by sunlight through conduction and radiation from land and water surfaces, by convectional mixing within itself, by latent heat of condensation, and by compression of the air ..... 14

61. The higher the temperature of the air, the greater the amount of moisture that is required to saturate it, consequently, the warmer the air, the better is that air as a transporter of water vapor..... 14

62. The rotation of the earth on its axis produces the succession of day and night which causes man's activities to be limited 14

63. Our sun is the gravitational and energy center of all the other members of the solar system ..... 14

64. All solar system bodies are visible by reflected light from the sun with the exception of the self luminous sun and meteors.. 14

65. The gravitational pull of the moon and sun upon the earth cause tidal waves in the solid and fluid earth..... 14

66. The nature of the universe helps explain events of the past, interpret events of the present, and forecast future events.... 14

67. Soils are formed by the chemical and mechanical association of rock sediments, organic matter, air, water, and bacteria.... 14

68. Soil texture is determined by the mineral particle size, shape, and amount of organic matter which determine the water permeated and retained by capillary action. 14

69. Soil-type areas are determined by the nature of parent-rock materials, type of climate, and past vegetal cover..... 14

70. Under agricultural practices of clean-till cropping, soils form less rapidly than erosion removes them, hence conservation practices are made essential..... 14

71. The character of soils on the earth determines the nature and growth of most plants and animals, when other factors are equal ..... 14

72. Soil fertility differs as organic matter, mineral foods, capillary water, bacterial population, and soil air vary..... 14

73. The health of plants and animals are affected by the presence or absence of essential minerals in the soil..... 14

74. Organic nitrogen is made available in the soil by certain soil bacteria which live on legume-type plants and make atmospheric nitrogen available to all plants.... 14

75. The amount and nature of surface-water runoff determine the initial phase of soil erosion ..... 14

76. Soils under clean-till crops and overgrazed grasslands are unprotected against the erosional action of wind and running water ..... 14

77. The per cent of runoff from precipitation depends upon the amount, intensity, and type of precipitation; the soil texture, composition, and thickness; the amount of surface slope; and nature of vegetal cover 14

78. Running water removes soil from one place and deposits it elsewhere..... 14

79. Soil erosion destroys soil animals, mineral content, organic matter, and texture, resulting in a more rapid rate of erosion.. 14

80. Water from sheet erosion aggregates to form gullies, gullies aggregate to form streams, streams gather into large rivers to erode as they flow to the ocean..... 14

81. Water supplies are derived from surface or subsurface sources and such supplies are depleted when consumption exceeds the accumulation rate in the sources. 14

82. Soil use, adapted to the natural processes of soil formation, maintains soil fertility and conserves the soil..... 14

83 Weather forecasts save much life and good from being destroyed and energy from being wasted..... 14

84. Productive land is scarce due to the erosion of good soil which takes place more rapidly than nature is reforming new soil. 14

85. The rocks of the earth's crust are composed of minerals and mixtures of compounds and elements..... 13

86. Differences in composition, origin, and systematic arrangement of molecules in mineral crystals produce different sets of physical and chemical properties for each mineral ..... 13

87. The differences in the natural availability, combustibility, and the bulk of various fuel minerals, determine their use. 13

88. Lakes are temporary water bodies, located at the ground water table which may be destroyed by sediments filling them or by streams draining them..... 13

89. Mountains are formed by such natural processes as igneous uplift, folding and faulting of strata, and erosional remnants, with each process giving a different topographic result ..... 13

90. Glacial deposits are formed when the ice melts and the rock debris is released to form an undulating but generally level land surface ..... 13

91. The ground water supply is furnished by permeating rain water, magmatic water, and ocean water seepage into porous rock strata ..... 13

92. The amount and distribution of surface waters depend upon the amount and nature of rainfall, the topography and porosity of the surface, and the evaporating capacity of the winds ..... 13

93. The oceans influence the erosion of the land in such ways as wave erosion of shores, contributing the original water for the water cycle, determining the mean sea level, and influencing the direction and velocity of the winds..... 13

94. Submerged valley harbors are produced by lowering the land, rising sea level, or both factors, and they possess large, deep, and well protected water approaches..... 13

95. Sedimentary rock strata are formed as horizontal deposits of sediments in shallow seas by the agents of erosion and deposition ..... 13

96. The normal succession of rock strata places the younger strata above the older strata, unless inverted by deformative forces ..... 13

97. The total of water evaporated equals the total of water vapor condensed, which allows the ocean water volume to remain generally constant ..... 13

98. The fact of primary importance in the history of life displayed by the geological periods is the orderly succession of living forms ..... 13

99. Each precipitation type results from definite sets of atmospheric conditions such as the temperature of dew point, the turbulence of the air, and the rate of water vapor condensation ..... 13

100. Air always contains some moisture which may be precipitated in part by lowering the temperature and/or lowering the air pressure..... 13

101. Air may be cooled to cause precipitation through heat loss by radiation, through contact of air with cold surfaces, by mixing of cold and warm air, and through cooling of air expansion ..... 13

102. High temperature and high humidity of the air cause low air pressure while low temperature and low humidity cause high air pressures ..... 13

103. Rising air will have its pressure decreased, decreased pressure will permit expansion, expansion will cause the lowering of temperatures, and a drop of temperatures may produce precipitation..... 13

104. Planetary winds are modified locally by the temperature and moisture differences between land and water bodies and by the change of temperature distribution with the change of seasons..... 13

105. Expansion of warm air as it rises, is the chief cause of cooling which usually results in cloud formation when dew point is reached ..... 13

106. Warm and cold fronts both produce precipitation by causing warm moist air to be cooled to dew point..... 13

107. Climate zoning on the earth is modified by the land and water distribution, by topographic variety, and by land vegetal cover contrasts ..... 13

108. Mild temperatures and moist climatic conditions are favorable to maintaining high soil fertility, to the absorption of surface water by the rock surface, and to the maintenance of high organic content in the soil by abundant vegetal growth... 13

109. Abrupt changes in weather occurs in the areas over which the boundary between cold and warm air masses move..... 13

110. The atmosphere retards heat loss by slowing radiations from the surface, however the earth will cool when the heat loss at night by radiation from the surface through the atmosphere exceeds the heat received from the sun during the day.... 13

111. Storms are produced when great contrasts in air density create violent convectional air currents..... 13

112. Storms usually occur along air-mass fronts where violent convections are commonly created ..... 13

113. All solar system bodies move about their gravitational centers in orbits which approach a circular value as an ellipse.... 13

114. Planets are different from stars by their apparent changing positions among the star pattern, by their reflected light, and by their visible disk when seen through a telescope ..... 13

115. The true motion of an astronomical body is determined in relation to the known motions of an observer, and some second astronomical body ..... 13

116. Organic and mineral matter in the soil supports bacteria and fungi which bring insoluble soil minerals into solution and make them available to plant roots for better growth ..... 13

117. The earth is a treasure-house of natural wealth, furnishing fuels, foods, air, water, and minerals to those who understand its operations, constituents, and change patterns ..... 13

118. The origin, distribution, availability, abundance, and use of mineral fuels and ore minerals determines largely the industrial and economic development of an area 12

119. Seacoasts have shifted because of the action of erosional and depositional agents, because of diastrophic forces, and/or because of changes of sea-level..... 12

120. Sheet-flow by surface water runoff contributes most of the sediment-loaded water to gullies, streams, and rivers for transportation to the ocean..... 12

121. The minerals in the solution state in ocean water represent the accumulation of the chemical weathering in the past..... 12

122. Running water wears away the surface of the land in amounts greater than the total erosional effects of all other erosional agents ..... 12

123. Earthquakes result from the faulting of rock strata by internal forces in areas of crustal weakness..... 12

124. The earth cooled on the surface to form a solid compact rock crust and an interior which is plastic under great pressure and heat..... 12

125. Glacial ice accumulates when more snow falls in winter than can melt in summer while the difference in the amounts of these two actions determines the rate of the glacier's growth..... 12

126. The shape of the earth is determined by the forces of gravity and of the earth's rotation which exert pressures on the earth's interior, the ocean basins, and the earth's crust ..... 12

127. Changing conditions on the earth in the past had similar sets of causes as those governing changing conditions today..... 12

128. Fossilization is the fate of very few animals and plants since fossilization requires those chemical conditions which permit mineral replacement of body hardparts and tissues..... 12

129. Abrupt environmental changes cause many kinds of life forms to become extinct, while some old forms endure and some new forms arise from the changing conditions. 12

130. Weather conditions are more commonly transported rather than being local in origin and their transportation is controlled by the seasonal migratory paths of air masses ..... 12

131. Climatic changes result from changes in elevation of the land, in solar radiation, in carbon-dioxide in the air, in ocean currents, in planetary winds, in vegetal cover, and in surface water suppliers..... 12

132. Climates are likely to be cold and dry when the latitudes are high, when the land has high altitudes, when the distances to water bodies are great, and when the locations are leeward to the wind directions relative to major relief contrasts..... 12

133. The elements of climate and weather are inter-related both in origin and function, consequently as one element is altered, all the other elements are modified..... 12

134. The atmosphere filters certain radiant energy or colors from sunlight according to its composition, thickness, and amount of impurities and transmits to the earth's surface selected radiant energy..... 12

135. The surface conditions on a planet are determined by the mass of that planet, its distance from the sun, and the functions of a possible atmosphere ..... 12

136. The material and motion similarities between the members of the solar system indicate that they have resulted from common causes of origin and of change..... 12

137. Life on the planets depends upon their surface temperatures being between the boiling and freezing points for water which makes it possible for planets other than the earth to support life..... 12

138. Planets with axes inclined from normal to the plane of their orbit of revolutions, have seasons resulting from their sun-planet relations during their revolution about the sun..... 12

139. The manner in which surface water may escape from soil surfaces depends upon the rainfall type, soil type, amount of surface slope, nature of vegetal cover, and the nature of the winds..... 12

140. Native vegetation is a reflection of the nature of the soil, water, climatic conditions of the past and present, as well as reflecting the nature of land-use by animals and man ..... 12

141. Economically important minerals have origins which make possible their natural abundance, ease of access, recovery costs, and uses ..... 11

142. Fuel and ore minerals occur in concentrated desposits in the earth by processes determined by their mode of origin and/or place of deposition..... 11

143. High temperatures increase the solubility of minerals in water and the speed with which dissolved chemical agents will weather minerals while lower temperatures have the reverse effects..... 11

144. The density, size, and shape of rock particles determine the ease with which turbulent flowing earth fluids transport them ..... 11

145. Rapidly flowing rivers cut V-shaped valleys when the gradient is high and the water-volume is large..... 11

146. High surface-velocities for running water result from steep slopes, from large volumes of water, and from small amounts of sediment loads ..... 11

147. The areal distribution of rocks at the earth's surface depends upon the effects of erosional agents, of rising magmas, of sediments deposited, and of rock structures formed ..... 11

148. Varied and diversified life forms, as recorded in fossils, parallel the varied and diversified conditions in which they live and were buried ..... 11

149. Cloud-types signify definite sets of temperature, air currents, and humidity conditions in the atmosphere..... 11

150. Types of climate result from types of average weather patterns which have zonal-geographic extents ..... 11

151. The sun and the earth are composed of the same elements, differing in the amounts and physical states of each element, while the other planets appear to be composed of these same elements..... 11

152. The duration of twilight will be greatest near sea-level and with a cloud or dust-filled atmosphere ..... 11

153. Matter in space is both luminous and non-luminous in almost equal amounts, with the non-luminous material consisting of objects with small mass values and of low atomic energy values while the luminous objects are the reverse..... 11

154. Many rocks furnish chemical elements and natural mineral substances for new and old industrial consumption..... 11

155. Streams carve specific sets of topographic forms for each stage of youth, maturity, and old age, unless they are interrupted by rock structures, rock hardness differences, and/or by diastrophic adjustments in the surface elevations..... 10

156. Streams have constancy and uniformity of water volume from the water seeping into the channel from subsurface sources while surface runoff causes the fluctuating water levels in the stream..... 10

157. The internal forces of the earth lift, lower, and/or distort the earth's crustal rocks while erosional and depositional agents work to offset the effects of these diastrophic changes ..... 10

158. The heat of volcanic and igneous activities is derived from the physical, chemical, and radioactive functions of deep-seated rocks ..... 10

159. Regions of glacial deposition possess those surface conditions of fertile soil, pure water, and level topography, composed of glacial drift materials..... 10

160. The removal of rock sediments from land to sea-floor creates stress forces which cause the sea-floors to settle and the land to be lifted..... 10

161. Most artesian waters are purified and filtered by permeating from the surface into underlying porous strata which waters accumulate to form a potable water supply 10

162. The physical features of the earth result from the aggradation and/or the uplift of the land in combination with the effects of degradation and/or depression of the land..... 10

163. The convectional currents in the oceans distribute heat from the equator toward the pole and moderate temperature values over the earth's surface..... 10

164. Evaporating water cools, and condensing water warms, resulting in a great heat transfer between areas of evaporation and areas of water condensation..... 10

165. The atmosphere is normally warmest near the earth's surface and the temperature decreases upward through the weather zone ..... 10

166. Definite patterns of weather elements are essential to the successful living of each plant and animal type..... 10

167. The causes for weather changes include such factors as temperature, humidity, and air pressure changes which can be observed in nature..... 10

168. Soils vary in kind and quality because of factors such as parent rock material, climate, vegetation cover, topography, and the use of the land..... 10

169. Surface-water runoff is most complete where the soil is eroded and the slopes are numerous..... 10

170. The social implications of the scientific aspects of conservation result in human behavior which is directed toward conservation education and action..... 10

171. The unused, inaccessible, and low-grade natural energy sources can be made available, useful, and desirable by employing new recovery techniques or by greater values given through increased demand for the energy sources..... 10

172. The natural deposits of ore and fuel minerals are limited in quantity, availability, and quality when considered for unlimited consumption ..... 9

173. The density of water and its ability to evaporate, condense, and flow, make it an energy source in nature..... 9

174. Alternate strata of limestone, sandstone, and shale verify the alternation of lime, sand, and clay which formed them.. 9

175. Rocks consist of mineral assemblages with definite mineral associations for each rocktype ..... 9

176. Geographical and geological correlation of rock strata make possible a world-wide record of past events..... 9

177. A hot earth is believed to have gradually cooled to become a place suitable for the support of life, with the elements of the atmosphere, the ocean water, and the rock minerals contributing to life's processes ..... 9

178. Life on the earth has developed from simple forms to more complex types as environments have become more varied and more complex..... 9

179. Rock strata may be formed by the compacting and cementing of sediments.. 9

180. The evolutionary records of life-forms, as revealed by fossils in rock strata, have revealed a systematic succession of changes 9

181. The heat-transporting capacity of ocean currents alters climatic conditions by carrying equatorial warmth poleward and polar low temperatures equatorward.. 9

182. Weather conditions result from definite cause and effect patterns in the atmosphere which are produced by its physical behavior ..... 9

183. Storms produce intensified forms of precipitation and abrupt changes in temperature ..... 9

184. Animals adjust their activities to comply with the weather conditions in order to preserve their comfort, needs, and life.... 9

185. Solar radiations are the result of energy released by the atomic fusion of small atoms ..... 9

186. Meteors are heated to incandescence by friction with the atmospheric gases.... 9

187. The uniform eastward rotation of the earth measures time accurately by making all rotations in the same time-interval.... 9

188. Our solar system is a member of our galaxy, as indicated by our view of the galaxy as the milky way..... 9

189. The unequal distribution of matter and energy in space and the influences of gravity, inertia, and radiations keep all objects in motion with ever changing space-relations ..... 9

190. Differences in soil, weather, topography, and past land-use cause good land-use practices to vary from place to place and from time to time..... 9

191. Exceptional and extreme weather elements disturb the balance of relations between soil, water, plants, and animals, since such extremes perform the task of rapid erosion and runoff..... 9

192. Mineral fuels are distributed in the earth independent of their consumption areas resulting in varied recovery rates.. 8

193. The physical and chemical nature of rock materials results from their conditions or origin and from the nature of subsequent changes in them..... 8

194. Water waves and their resultant water currents erode and build shores on a mean sea-level, which determines the horizontal and stratified nature of rock strata. 8

195. Rivers and valleys grow old by reducing the maximum elevations and relief contrasts of the land to long gentle slopes ending at sea-level..... 8

196. Sedimentary rock strata contain structures, textures, and space relations which reveal the conditions of deposition, the nature of erosional and depositional agents, and the composition of the sediments.... 8

197. Topographic contrasts cause climatic contrasts by modifying winds on both horizontal and vertical bases..... 8

198. Since temperature in the weather zone of the atmosphere usually varies from just

below freezing to considerably above that value, most precipitation occurs as snow or rain ..... 8

199. Air pressure zones are distributed on the earth extending in a general east-west direction, consequently planetary wind patterns are formed with related areal geographical distribution..... 8

200. High horizontal air-pressure gradients produce destructive types of horizonal winds ..... 8

201. The superimposition of contrasting air layers, and the energy released from the condensation of water vapor make possible the destructive wind violence of storms... 8

202. Comets move about the sun in highly elliptical orbits as evidenced by their passages near the sun..... 8

203. The masses, temperatures, motions, and distribution of other astronomical bodies give evidence of the astronomical origin and nature of the earth..... 8

204. Planetary satellites have planets as their gravitational centers and are dependent upon the sun for energy..... 8

205. Solar system bodies, which reflect sunlight and revolve about a gravitational center, show phases when viewed from the earth ..... 8

206. The combined motions of rotation and revolution produce the apparent westward displacement of stars across the celestial sphere ..... 8

207. The quality of sunlight on the earth's surface results from the nature of solar radiations reaching the earth's atmosphere and the radiations passing through that atmosphere ..... 8

208. Daylight and darkness intervals on planets will be equal in period at the time of equinoxes when the north-south limits of twilight fall on the rotational poles.... 8

209. Sunlight is reflected, refracted, and absorbed in passing through a cloud of water droplets with the transmitted light consisting largely of long wave-length red rays ..... 8

210. Astronomical matter exists in space with bonds of force controlling their motions and space relations..... 8

211. The weak stellar radiations from distant stars result from their great distances from the observer and/or their low radiation intensity at the star..... 8

212. Soil minerals in solution help support life on the earth by furnishing structural and catalytic materials for the fundamental organic functions of all life forms..... 8

213. Sheet-erosion control results from good land-use soil conservation practices which diminish water runoff at the natural source and lessons flood control needs in the larger drainage channels..... 8

214. The earth's resources are inexhaustable, renewable, or non-renewable depending upon their abundance, restriction of deposits by nature of origin, and/or the amount of natural regeneration..... 8

215. Wildlife conservation measures are believed to help preserve the biological balance in nature by allowing the competition of each life form with the other forms 8

216. The space relations, availability, and ease of refinement of energy sources and ore minerals in nature determine their economically profitably consumption centers 8

217. Energy sources may change from abundant to scarce when they are in fixed supply, but with increased demand, consequently a search for new sources is necessary ..... 8

218. Most ore mineral bodies are found in or near contact zones between igneous and sedimentary rocks, consequently most such deposits are found in mountainous areas.. 7

219. Water-soluble mineral salts have been deposited in natural concentration orebodies by land-trapped ocean water which has evaporated to supersaturation in arid climates ..... 7

220. Rock minerals contain chemically stored energy and elemental substances which are released when the natural conditions, required for the change, occur.... 7

221. The uneven flow rates of wind, water, and ice over uneven land surfaces produce turbulence in the motions of the eroding agent, enabling it to roll, bounce, or suspend the rock material, being transported.. 7

222. Stream patterns are determined by such factors as rock hardness differences, general slope of the surface, rainfall totals and intensities, and the age of the stream.. 7

223. The plastic nature of deep-seated rocks allows them to stabilize the shifting loads of water, ice, and rock sediments from land to sea and the reverse, by the process of diastrophic adjustments..... 7

224. The rock fragments plucked, suspended, or shoved by a glacier, serve as the tools of abrasion for further rock weathering and erosion by ice action..... 7

225. Glacial activities of the present time are the indicators of glacial activities of the past in respect to origin, erosion, and depositional forms ..... 7

226. Ocean water contains many times more dissolved gases, such as carbon-dioxide, than does the atmosphere, which makes photosynthesis much more functional for marine than for land plants..... 7

227. Ocean currents result from the combined effects of temperature, density, and salinity differences in ocean water and from

the effects of winds moving over the ocean surface ..... 7

228. Changes in land and water levels along shorelines alter the physical nature of such shorelines, such as the making of irregular shores from sinking land or by rising water, and the formation of straight shores from rising land or sinking water levels.. 7

229. Electrical discharge from clouds results from the aggregation of surplus electrical energy released when numerous water droplets join in forming large drops, producing lightning ..... 7

230. The entire solar system moves within our galaxy to which it belongs, and the galaxy moves through space in relation to other galaxies ..... 7

231. The periods of revolution for the planets vary in proportion to their distances from the sun..... 7

232. Stars are grouped into apparent constellations, which possess width and length but with infinite depth, which indicates that great differences in distances to various star members exist..... 7

233. The apparent magnitudes of astronomical bodies are directly proportionate to the absolute brightnesses and inversely proportionate to their distances from the observer ..... 7

234. The color of a star reveals its temperature, mass, and position in the cycle of matter-energy relations..... 7

235. A star will vary in brightness because of such factors as radial motion, variation in absolute brightness, and/or being eclipsed by non-luminous matter..... 7

236. Land-classes are determined by the amount of surface slope, by the nature of the climate, by the texture and fertility of the soil, and by the past utilization of the soil ..... 7

237. Ore and fuel minerals have their production determined by the state of their natural occurrences and by the techniques of their recovery and refinement..... 7

238. Types of fuel minerals are determined by the nature and concentration of organic tissue in the sediments, by the amount of change since burial, and by the nature of migration to points of concentration..... 6

239. A glacier can move by plastic flow because ice can melt under pressure without being warmed, and can freeze with reduced pressure without being cooled... 6

240. The texture of rocks depends upon the rate of crystallization, upon the type and variety of minerals solidifying, and upon the order of their crystallization.... 6

241. The succession of rising and eroding continents is recorded in the succession of deposited rock strata around the margins of past and present land masses..... 6

242. Drops of water usually form into hailstones when they are carried by gravity or air currents through alternate air layers with temperatures above and below the freezing point for water..... 6

243. When the atmosphere is supersaturated with water vapor and when the natural nuclei are absent, rain will not occur until nuclei are supplied by nature or by man..... 6

244. All earth science facts are related to each other in some scientific fashion and the consequent plant and animal responses are related to one another and to their inanimate environment by indisputable associations ..... 6

245. The entire solar system moves with the galaxy to which it belongs, through an orbital path around the center of that galaxy ..... 6

246. Planets with long rotational periods have long periods of daylight and darkness and great diurnal temperature contrasts.. 6

247. Small solar system bodies are unable to collect or retain gaseous atmosphere due to their low gravitational forces..... 6

248. The number of satellites possessed by each planet depends upon the mass of the planet, upon their distance from the sun, and upon the distribution of matter in the solar system ..... 6

249. The surface features on the moon are a record of its physical history, because the evidence of past events have not been removed by the effects of subsequent events. 6

250. Energy radiated into space by luminous stars is only very slightly absorbed in space by matter since space is sparsely occupied by matter..... 6

251. Raindrops have a compacting effect upon the soil's texture, which results in more surface-water runoff and a higher rate of sheet erosion..... 6

252. Wildlife habitats occur between diverse types of vegetation where one type is the food source and the other vegetation type is the wildlife cover..... 6

253. The various properties possessed by different rocks and minerals have indicated their uses ..... 5

254. The identification of air mass types is possible by measuring weather elements on a vertical and/or horizontal basis..... 5

255. Climates have changed in the past much as they have been changing today, as indicated by comparing fossil records with present-day climatic changes..... 5

256. The highly variable climatic areas of the world have produced the highest levels of human energy and the greatest centers of populations ..... 5

257. Interplanetary space contains dangerous radiations, limited fuel sources, and

meteoritic hazards, which will become interplanetary travel problems..... 5

258. Stars are distant suns with self-luminous properties which possess differences in their place in the cycle of mass-energy relations ..... 5

259. Nature protects the soil by its vegetal cover, which controls the rate of surface erosion, leaching, and depletion of soil air and water ..... 5

260. The environmental changes for plants, animals, and humans are the combined results of chemical, physical, and biological functions on the earth..... 5

261. A sequence of functions on the earth's surface such as deposition, uplift, erosion, depression, and renewed deposition are recorded in an unconformity..... 4

262. Glacial abrasion occurs in proportion to the weight of the ice, the amount of rock tools, and the velocity of ice motion.. 4

263. The exchange of air from equator to pole and reverse, tends to lower temperature contrasts on a latitudinal basis, yet it produces winter and summer temperature extremes for the intermediate latitudes... 4

264. The recreational and transportational properties of water have resulted from its buoyancy action ..... 4

265. Rivers serve as controllers of actions by plants and animals in serving as barriers and/or highways of transport and travel.. 4

266. The oblate spheroidal shape of the earth results from the centrifugal forces of its rotation which increases the equatorial diameter and decreases the polar diameters 4

267. Galactic systems are aggregates of radiant galaxies which are held together by central cores of gravitational concentration 4

268. Most rock-minerals contain desirable metals and/or non-metals in compound form, which cannot be economically refined 3

269. Rock structures, formed by the earth's internal forces, make possible the concentration and surface availability of fuel and ore minerals ..... 3

270. The heat and pressure influences of magmas upon solid surface rocks cause the formation of metamorphic rocks and minerals ..... 3

271. All deformative processes, acting on the earth's crust, tend to disturb the normal sequence of rock strata..... 3

272. The earth's total water supply is slowly diminished by the chemical union of water with weathering rock minerals.. 3

273. Most stars, including our sun, have gravitational centers either too great or too small to permit the formation of a planetary family ..... 3

274. Cold astronomical bodies absorb and reflect the light from self-luminous bodies which help distribute radiated energy throughout astronomical space..... 3

275. The earth's atmosphere spreads to occupy space under the control of gravity, while losing and gaining substance to/from space ..... 3

276. Stars differ in their absolute magnitude values because they differ in mass, composition, and resultant temperature... 3

277. Definite combinations of crystallized minerals form from given molten mixtures of magma as they slowly solidify..... 2

278. Some ore minerals, such as iron ore, are limited to the deposits of only a few geologic formations where the conditions were favorable for their deposition..... 2

279. The natural processes for producing change in rock materials from form to form, have demonstrated the causes for future change ..... 2

280. Rock strata which are brittle may fault with forces which are applied either rapidly or slowly, while strata which are flexible, will fold under all speeds of force application ..... 2

281. Some magmas become more fluid as they rise toward the surface because of the addition of mineralizers, while most magmas become more viscous as they are cooled in rising toward the surface without the addition of mineralizers..... 2

282. Igneous activities alter the topography and composition of the surface, and subsurface materials, which interrupts and modifies the work of weathering, eroding, and depositing agents..... 2

283. Continental glaciers are formed when climatic temperatures are lowered by the influences of high altitude continents, of restricted ocean currents, of low carbon-dioxide content in the atmosphere, and of low intensity solar radiations..... 2

284. Mountain glaciers produce steep and rugged topography by vertical quarrying of rocks from steep slopes while continental glaciers level the land by general rock removal or deposition..... 2

285. Solution and deposition of minerals by ground water, concentrates and/or disseminates minerals, depending upon their relative solubility in each new chemical environment ..... 2

286. The oceans have sets of environmental conditions, stratified on both a horizontal and vertical basis, resulting in each set of conditions producing its own set of biological responses ..... 2

287. Subsurface rock structures influence the eroding topography with the resistant dipping rock strata composing the ridges and the less resistant strata composing the valleys ..... 2

288. The age of rock strata can be determined by comparing the nature and rate of present natural processes of erosion, deposition, and consolidation with the evidences of these processes in ancient strata. 2

289. Comet tails grow and acquire great length when comets approach the sun and these tails diminish in length as the comets recede from the sun..... 2

290. Comets appear to move through the pattern of stars as they approach or recede relative to the sun, since their motion is observed from the earth..... 2

291. Meteors have had their abundance decreased during the history of the earth since space near the earth's orbital path around the sun has been swept relatively clean of such objects..... 2

292. The periods of rotation for the planets differ from one to the other as a result of their having picked up differing amounts of meteoritic materials whose inertia determined the planets rotational directions and periods ..... 2

293. The reflecting ability of an astronomical body depends upon its topography, vegetal cover, rock surface texture, the content and thickness of its atmosphere, and the physical state of its surface water supply ..... 2

294. Reflecting astronomical bodies have brightnesses increased when located near the light source, near the observer, and by possessing efficient reflecting surfaces..... 2

295. Solar system bodies, without atmospheres, do not exhibit erosional features but rather they possess great temperature contrasts ..... 2

296. The revolution of our solar system around the center of our galaxy has given us long-period climatic changes such as those believed to have caused the infrequently occurring glacial periods..... 2

## Discussion of Results

In this investigation several factors operated to insure a reasonable degree of validity of the data collected, and to verify the results obtained. One of these factors was exercised in designing the study, in the selection of appropriate techniques of research, in the collection of the data, and in the analysis and classification of the data. Furthermore, in the preparation of letters and forms to be sent to teachers, publishing companies, and jury members, effort was made to make the letters, forms, and instructions simple and objective, and as economical as possible of the time and effort of the persons cooperating in the investigation.

Most of the criteria employed in this study for the identification of earth science principles, the selection of sources of material, and jury personnel are either similar or identical to those employed in other investigations of a similar nature. The use of teachers of the earth sciences in refining and editing statements of principles was judged to be desirable since these teachers were familiar with the terms, facts, and relationships involved in the principles. Likewise, the use of science educators as evaluators was judged to be preferable in determining the desirability of earth science principles for inclusion in the science program of the general education in the secondary school. Such members of a jury should be capable of understanding the science fact and its scientific and social implications in the general education program of the secondary school.

Some limitations are inherent in the techniques employed in this investigation. First, the compiling of earth science source materials from information supplied by teachers, publishers, and standard references may not supply information entirely comprehensive; however, the techniques that were used appear to be most logical in order to meet the needs of this investigation. Second, the criteria employed in selecting source materials, members of juries, and earth science principles and applications may have limited the selections; however, many of the criteria employed have been used acceptably in other similar investigations and judged to be adapted to the needs of such investigations. Third, the methods employed to analyze the source materials for statements of earth science principles and applications are subject to the limitations inherent in word meanings. In the formulation and selection of statements of principles from applications, however, the use of a jury to refine

and edit the principles and the securing of a high index of validity for the analysis of sources indicate satisfactory results in this phase of the investigation. Finally, the determination of the relative importance of principles by a jury, results in relative importance ratings derived from only a few people. Yet, when it is considered that the members of the jury represent outstanding leadership in the field of science education and when the observation is made that the relative importance ratings for a particular principle were usually similar in value from among the different jury members, it was judged more desirable to have a group of five recognized science educators on the jury of evaluation than to have a large number of less capable people evaluate the principles. The meticulous care with which each principle was evaluated by each of the jury members was evidenced by the detailed notes included with the relative importance ratings which were returned to the investigator with a copy of statements of earth science principles which had been sent to each evaluator.

## CONCLUSIONS

1. There is an abundant number of source materials available for use in teaching the earth sciences in the science program of general education in the secondary school.

2. There are many principles of the earth sciences which may or may not be desirable for inclusion in the science program of general education in the secondary school.

3. Based on the judgment of science educators, there is an abundant number of principles of the earth sciences that should be included in the science program of general education in the secondary school.

4. In all, 296 principles of the earth sciences received algebraic sums of plus 2 or more based on the independent ratings of a jury of science educators and these principles are judged to be desirable for inclusion in the science program of general education in the secondary school.[8]

5. There were 36 earth science principles which received algebraic sums of less than plus 2 based on the independent ratings of a jury of science educators. These 36 principles of the earth sciences are judged to be undesirable for inclusion in the science program in general education in the secondary school. These principles may be used, however, as guides to the selection of earth science materials in other science offerings in the secondary school.

6. The 296 principles of the earth sciences that are judged to be desirable for inclusion in the science program of general education in the secondary school are reasonably well distributed among the four areas of the earth sciences. Approximately one-third of these principles of the earth sciences related primarily to geology, one-fourth to physical geography (including weather and climate), one-fourth to astronomy, and one-sixth related primarily to the scientific aspects of conservation.

## RECOMMENDATIONS

The findings of this investigation seem to warrant the following recommendations:

1. The earth science principles judged as desirable in the investigation should be included in the science program of general education in the secondary school as guides to the selection of appropriate earth science materials.

2. Earth science principles determined in this investigation as undesirable for inclusion in the science program of general education in the secondary school should be considered for inclusion in other science curricula in the secondary school.

[8] Caldwell, Loren T., "A Determination of Earth Science Principles for Inclusion in the Science Program of General Education in the Secondary School," Doctor's Thesis, School of Education, Indiana University, Bloomington, 1953. P. 65–95.

### Suggestions for Further Study

1. Further studies are needed in which techniques are used other than those employed in this investigation for the purpose of determining the earth science materials and teaching program needed in order to implement the desirable earth science principles into the science program of general education in the secondary school.

2. Earth science principles determined in this study as undesirable for inclusion in the science program of general education in the secondary school, should be studied to determine the desirability of each principle for inclusion in other science curricula in the secondary school.

3. Further studies should be undertaken to determine the learning difficulties which are encountered when the desirable earth science principles are employed as guides to the teaching of earth science in the science program of general education in the secondary school and to determine the difficulty of comprehension associated with the attempt to grasp the domain of facts which are related to each desirable earth science principle reported in the findings of this investigation.

4. Investigations are needed in order to determine whether the desirable earth science principles are most effectively comprehended when such teaching methods as lecture, laboratory experiments, demonstrations, group study, field trips, and/or combinations of these methods are employed.

# A STUDY OF THE OPINION OF STUDENTS ON COLLEGE GENERAL EDUCATION SCIENCE *

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## 1. Introduction

It is recognized that there is a trend toward increased student responsibility for evaluating courses of instruction in general education on the college level. Some of the principles on which this trend is based follow:

1. Students that participate in the evaluation of courses give useful suggestions which may be used in improving courses.
2. Evaluation should be a cooperative endeavor involving students and teachers.
3. The process of evaluation is in itself a valuable learning experience.
4. Out of the process of evaluation should grow leads for improving courses and the teaching-learning situation.

With these principles in mind, a study was conducted in two courses in general education science at Morgan State College during the winter session of 1951.

A brief description of the courses which students evaluated follows:

Science 102. Physical Science and Human Adjustment; Part I. 3 Semester Hours Credit:

This course was designed to present an integrated study of the physical sciences involving man's adjustment to matter and energy and its application to personal and social living. Six units were designed to develop an understanding of the following major concepts: (1) man has applied his knowledge of physical properties and physical changes to overcome many physical limitations, (2) man has discovered and harnessed different forms of energy, (3) energy may be propagated through the ether and through matter by means of vibrations, (4) the applications of magnetism and electricity have greatly modified the activities of mankind, (5) man is mastering his material world through an ever increasing understanding of its nature, and (6) creative chemistry has contributed greatly to man's physical progress. Part I was recommended for students who have not had high school courses in physics and chemistry.

* Paper presented at the twenty-seventh annual meeting of the National Association for Research in Science Teaching, Sherman Hotel, Chicago, Illinois, March 30, 1954.

SCIENCE 102. PHYSICAL SCIENCE AND HUMAN ADJUSTMENT; PART II. 3 SEMESTER HOURS CREDIT:

This course was designed to present a study of the physical universe, including integrated units in Astronomy, Geology, and Meteorology. Emphasis was directed towards the development of a functional scientific method of reflective thinking as used in analyzing and solving problems and aiding the student to deal intelligently with the quantitative aspects of his physical environment. Part II was designed primarily for students who have had courses in physics and chemistry. Five units were designed to develop an understanding of the following major concepts (1) the intelligent solution of problems as they arise is the price of liberty, (2) the universe is a vast system of parts moving and changing under the influence of a flow of energy, (3) continuous changes in the earth's surface have brought about conditions which make possible the life of modern man, (4) man has applied his knowledge of physical properties and physical changes to overcome many physical limitations, and (5) man's physical welfare is the most important problem of physical science.

During the school year 1953–54, students may satisfy the physical science requirement for graduation by successfully completing either Part I or Part II.

SCIENCE 101. BIOLOGICAL SCIENCE AND HUMAN ADJUSTMENT, 3 SEMESTER HOURS CREDIT:

This course was designed to present a study of the biological materials commonly considered to be important in relationship to general education. Emphasis was placed upon the life processes as they are displayed in man. The course includes a discussion of metabolism, growth and development, life and environment, human behavior, and the economic importance of plants and animals. Some consideration was given to human biology in terms of social welfare.

Five integrated units were designed to develop understandings of the science principles associated with (1) the nature of life, (2) the maintenance systems of the human organism, (3) the relation of animals to human welfare, (4) the relation of plants to human welfare, and (5) heredity and evolution.

The following aspects of the courses were studied: (1) objectives and content, (2) methods employed in instruction, (3) teaching aids used, (4) instruments used to evaluate the achievement of students, (5) the physical attractiveness of the classrooms and laboratories in which courses were conducted, and (6) suggestions for improving courses.

The investigation was the second in a series of three research studies which have been sponsored by the Committee on General Education Science at the College.[1] The Committee was composed of representatives of the departments of biology, chemistry, physics, and science education.

## 2. PROCEDURE FOLLOWED

The method employed involved a modification of a technique described by Carman[2] which had been used at Columbia College, Columbia University, to gather the opinion of students on general education courses in that institution. The modified technique consisted of the following procedures:

1. Students enrolled in each of the 14 sections of general education science in the fall term of 1951, chose one of their number as a section representative.
2. A meeting of the section representatives and course instructors was held.
3. The conferees prepared and agreed upon a series of "Questions for Discussion." This material was mimeographed and each student in the 14 sections received a copy.
4. At the end of the semester each representative with the instructor not present spent a class hour with his fellow students in discussion of the course; its content, assignments, methods of instruction, and the like. Student recorders kept careful records of the discussions in each section.
5. The entire course staff, the section representatives, and members of the Committee on General Education Science spent an evening at a dinner meeting at which the student representatives presented the reports of their sections.

The suggestions from students and the discussions that followed constitute the

[1] The first study entitled "A Study of the Convictions of Students and Faculty on College General Education Science" was presented at the Philadelphia meeting of the American Association for the Advancement of Science, December 28, 1951. Frasier, Thomas P. and King, John W., "Opinions on General Education Science," *Journal of Higher Education*. 25:274–276, May, 1954.

[2] Carman, Harry J., "Letter to President O. W. Snarr," *Notes and Comments on General Education*, Vol. I., No. 1, Nov., 1950.

main portion of the discussion which follows:

*Objectives and Content of Courses in General Education Science*

The four questions formulated and used in connection with the objectives of the courses probed for expressions from students on the validity, achievement, and extensiveness of objectives. An additional query asked whether or not additional topics should be included.

The discussions conducted and the reports presented at the dinner meeting were recorded. This record contained the contributions that students and faculty members made to the discussions.

Nine of twelve section representatives reported that the courses had "a worthwhile set of objectives." The consensus of opinion in two of these nine sections was that the objectives of the courses should have been listed in mimeograph form and discussed with students. The discussion at the dinner meeting, also, underscored this point. The majority of students in one of the sections felt that the mimeograph outline of the courses, which had been placed in the hands of students, contained implied statements of objectives.

Three of the section representatives reported some confusion among the students as was reflected in the following kinds of statements: "We were not given a set of objectives; therefore, we cannot state whether the objectives were worthwhile." "Everyone did not know what the objectives were; however, when the objectives were explained, it was felt that they were good." "Some said there were no objectives of the course and others said there were."

The majority of students in seven of eleven sections expressed the opinion that objectives were being achieved. The consensus of opinion, however, in one of these seven sections was that the time alloted to the courses was not adequate to develop fully the objectives.

Three of eleven section representatives reported that the objectives were not being achieved. The report from an additional section indicated uncertainty as to the degree to which the objectives were being accomplished.

Opinion among students in the various sections seemed to be about equally divided on whether additional objectives should be included in the courses. Two examples of this divided opinion were reflected in the statements that follow: "There is no need for additional objectives since the course is only a 'survey'". "Yes, there is a need for additional objectives for a 'survey course'".

Reports, presentations by section representatives, and the discussions at the dinner meeting indicated that students believed that the following topics should be included in the courses: the materials needed to pass the science section of the graduate record examinations; diseases of man; a more detailed discussion of atomic energy and of the earth science; man's nervous, skeletal and muscular systems; human reproduction; sex education; and biological-human relationships.

One section representative reported decisively as follows: "some of the topics now studied should be abolished and others included, such as more emphasis on man and the part that plants and animals play in man's development." Another representative said "some topics in physics not now covered, but needed for graduate record tests should be added. The number of hours needed to adequately conduct the course could be included by eliminating some unnecessary electives."

This interest in man is consistent with the results of research in general education science at Colgate University. The interest in the development of functional information and facts concerning such pressing problems as atomic energy; plants and animals, and the role of the earth sciences in human welfare is consistent with the

recommendation of the National Society for the Study of Education.[3] Moreover, students in this study indicated a real desire for a discussion of the objectives of the course based on a mimeographed listing of such objectives. The upper-classmen who were registered in the courses expressed a great concern for the development of competence needed to pass successfully the graduate record examination. It is admitted that while this may be on the outside of the scope of general education, it is nevertheless a real problem for students who are prospective candidates for admission to graduate schools.

### *Methods of Instruction Employed*

Four questions were used to probe for answers on the effectiveness of methods that had been used by instructors. These questions involved the competence of the instructors in lecturing, conducting class discussions, encouraging class participation, and presenting the materials of the courses.

Eight of eleven section representatives reported that the instructors did not engage in excessive lecturing. Two of three sections indicated that the instructors did an excessive amount of lecturing. The students felt that this technique was necessary because they did not participate sufficiently to "carry the discussions."

Seven of nine sections believed that a reasonable amount of time had been allocated to discussions of student questions.

Students in general education courses sometimes complain that some lectures and discussions are conducted at a graduate school level. The instructors in the courses and the section representatives decided to probe into the validity of this complaint in so far as it could be found in this study. The question as put to these students was, "Are the classroom activities conducted at the student's level?" Here the opinion favored, but only slightly, the affirmative answer. Five of the nine section representatives reported that classroom activities were conducted at the student's level. Three sections indicated that the instructor talked "over the heads of the students." The fourth section thought that the teacher talked "too fast."

The students studied gave some thoughtful suggestions on methods of presentation. Among them were the following:

1. Limit the work of a day to one specific topic and build the demonstrations around this topic.
2. Secure a more suitable and adequate text. Follow the text.
3. Require students to take more notes.
4. Correlate assignments and classwork.
5. Make assignments more explicit.
6. Give an adequate background of information before presenting (showing) slides.
7. Develop on the part of the instructor a more congenial attitude toward students.
8. Avoid or eliminate the introduction of foreign topics to the course.
9. Make lectures more informal, and more in detail.
10. Perform more demonstrations, experiments, and show more films.
11. Schedule smaller classes so that students can perform individual experiments.
12. Study the vocabulary and devote some time to drill on terminology in class so as to aid in bringing the lecture to the student's level.
13. Omit notebooks and give additional assignments.

### *Teaching Aids Used*

The questions centered in teaching aids probed for evidence which tended to support the widespread use of visual and auditory aids in the courses. A question in this group asked if a period for individual laboratory should be included. Still another question asked if the courses should be extended to two one-year courses.

Some of the visual and auditory materials used and integrated into the courses were: materials collected from the environment; demonstrations of scientific principles; models; field experiences; exhibits; and showings of films, slides, and film strips.

[3] National Society for the Study of Education. *Science Education in American Schools.* Forty-sixth Yearbook, Part 1, Chicago University of Chicago Press, 1947.

Eight of eleven sections reported that sufficient audio-visual aids were used. One section was uncertain as to whether or not these aids were sufficient. One of the two section representatives reporting on the insufficiency of these aids claimed that these devices were good, but that the course instructor did not use enough of them.

Seven of eight sections believed that demonstrations were sufficient.

In response to the query: "Did you find library materials adequate?" the voting was as follows: yes, five; no, three. One of the three sections that gave a negative vote to this question said that the references were too limited. The discussion at the dinner meeting on this question indicated that students regarded the accessibility to reference materials as a problem. It was reported that commuting students found it difficult to secure some library books.

One of the controversial issues on general education science is whether courses should be conducted with periods for laboratory work. There was considerable feeling by some members of the departments of science that individual laboratory work should be included. There was considered opinion, also, that within the limits of two-three semester hour courses; there was not sufficient time for the inclusion of such laboratory work. Eight of the twelve sections reporting on this question gave an affirmative vote. The discussion at the dinner meeting served also to underscore this opinion. It also served to reveal some sharp divisions of opinion. Two of the four sections that reported negatively for individual laboratory work said: "the course is short and much has to be covered"; and, "this is only a survey course." [4]

Members of the departments of science are in substantial agreement that the two general education science courses should be extended to two full year courses. Moreover, there is agreement that the course in the physical sciences should precede the course in the biological sciences. In an effort to gather student opinion on these two proposals, these two questions were asked: "Should course be extended to a year course?" "If so, how many semester hours for the entire course?" Opinion was almost equally divided on this query. Seven of thirteen sections answered, yes. Three of these seven sections indicated that six semester hours of credit should be allocated to the physical sciences and a like number of hours to the biological sciences. Six of the thirteen sections indicated that there was no apparent need to extend the courses. One of these six sections reported a qualifying answer as follows: "If so, six hours should be given."

Two sections probed into the question as to whether or not the physical sciences should precede the biological sciences. One section favored the physical sciences; the other, felt that the biological sciences should come first.

### *Methods of Evaluation Used to Assess Student Achievement*

The three questions used on evaluation were: (1) Do you feel that sufficient tests are used in the course?; (2) Do you feel that the test items are fair questions?; and (3) In addition to tests, what other items for evaluation should be required of students?

Six of ten sections agreed that sufficient tests were used in the courses. Eight of twelve sections believed that the items used on the tests were fair. Three sections reported that the items were unfair, and one section was uncertain as to whether or not the items were fair.

Question 3, which is referred to above, elicited a number of suggestions. There was a consensus of opinion that students

[4] The term "survey" is a carry-over from the time when the courses were actually described and taught as "survey courses." At the present time both courses consist of integrated and unified units of work.

should be provided with opportunities in addition to examinations for improving the individual grades earned in the courses. Seven sections reported that more attention should be devoted to class recitations, and that these recitations should count in assigning marks. Students suggested the following as the kinds of things instructors could do to assist them in improving their grades:

1. Give weekly quizzes for boosting grades and follow these up with the major examinations. Tests should be more frequent and shorter.
2. Evaluate and count general interest in the class.
3. Assign and evaluate laboratory projects.
4. Give written home assignments.
5. Assign and evaluate book reports.
6. Assign and evaluate notebooks.
7. Give more essay tests.
8. Give special assignments (projects) for improving grades.

One of the section representatives reported that his section agreed that: "students are too grade conscious."

The discussions at the dinner session indicated strong convictions on the need for administering tests more frequently; for greater student participation; and for the evaluation of achievement in terms of projects.

### *Physical Setting for Courses*

The question on the physical setting for the courses probed for suggestion on ways of improving the physical attractiveness of the rooms.

The suggestions given were:

1. Use cabinets for scientific displays.
2. Encourage students to be more careful in keeping the rooms clean.
3. Place posters on the wall.
4. Place plants in the room.
5. Use more charts and posters.
6. Use colored pictures of specimen.
7. Place scientific clippings on a bulletin board.

A few additional suggestions indicated the need for some improvement in maintenance. These suggestions focused attention on the acceptance of certain responsibilities associated with the improvement of teaching and learning. In some way colleges must become increasingly alert to the need for setting the physical stage for effective teaching.

The role of the teacher in improving the attractiveness of the rooms was likewise indicated in some of these suggestions.

### *Suggestions for Improving the Courses*

The question used in this category asked: "What other items do you suggest for making this a better general education course?" The suggestions given are tabulated below:

1. Schedule panel discussions.
2. Direct more attention to the development of current events or recent advances in science.
3. Schedule more movies.
4. Teacher should act as a guide in class discussions.
5. Familiarize students with the diagrams used on the tests.
6. Select another textbook.
7. Conduct more field trips.
8. Schedule smaller classes.
9. Assign more instructors to the courses.
10. Use individual class tests rather than departmental examinations.
11. Develop better student-teacher relationships.
12. Course in physical science should be given before the course in biological science.
13. Place more emphasis on the human body.
14. Introduce a unit on sex education.

## 3. CONCLUSIONS

The most significant findings revealed in the total study follow:

1. The majority of sections indicated that the objectives were being achieved, and that the objectives were good. Students felt that the course could be made more interesting and meaningful if the objectives were listed, mimeographed, and discussed.
2. Approximately one-half of the sections reported that the content of the course should be extended to include such topics as: the materials needed to pass successfully the science section of the graduate record examination; diseases of man; a more detailed discussion of atomic energy, and the earth sciences; man's nervous, skeletal and muscular systems; human reproduction; sex education; and biological-human relationships.
   Other suggestions included: selection of a more adequate text; increased use of panel

discussions; inclusion of more materials on current events or recent advances in sciences; increased use of movies; familiarization with the diagrams used on the tests; development of better student-teacher relationships; increased use of field trips; and increased emphasis on the human organism.

3. More than one-half of the sections expressed the conviction that the two courses in general education science should be expanded as follows: six semester hours in the physical sciences, and six in the biological sciences.
4. More than one-half of the sections reported that individual laboratory work should be introduced into the courses.
5. Slightly more than one-half of the sections thought that a sufficient number of tests were administered. More than one-half, eight of ten sections, reported that the items used on the tests were fair.
6. More than one-half of the sections expressed a desire for a greater amount of student participation in classes. Students believed that participation in classes and projects assigned by instructors should be more explicitly evaluated in grading. There was a strong feeling at the dinner meeting that students should be provided with opportunities in addition to examinations for improving their grades. They suggested such devices as laboratory projects, written home assignments, notebooks, evaluations of "general interests" in classes, special tests for "boosting" grades, and book reports.
7. The discussions at the dinner meeting and the reports from various representatives of sections indicated that students were placing emphasis on grades rather than on the achievement of the objectives of the courses.
8. The majority of sections reported that the teaching aids used were adequate, but suggested a more extensive use of these devices.
9. The majority of representatives of sections reported that library materials were somewhat inadequate. The discussion on this point at the dinner meeting tended to show that this inadequacy was due to the difficulty experienced by commuting students in securing certain reference books.
10. Students gave some helpful suggestions for improving the physical attractiveness of the classrooms. The suggestions involved: maintenance service, and improvements that could be inaugurated by the instructors.

In summary, the systematic collection of student opinion on the improvement of instruction as was represented in this study may be used as a factor in determining and improving the content of courses, and in facilitating the teaching-learning situations.

# THE EFFECT OF HIGH SCHOOL PHYSICS AND COLLEGE LABORATORY INSTRUCTION ON ACHIEVEMENT IN COLLEGE PHYSICS *

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## 1. INTRODUCTION

LABORATORY work in elementary college physics is evaluated in most schools almost entirely by means of laboratory reports written by the student outside the classroom. The need for more precise instruments for measuring laboratory achievement has been pointed out elsewhere.[1] A number of paper-pencil laboratory tests in general physics were constructed and administered at the University of Minnesota in 1952–53.[2] The analysis of paper-pencil laboratory pre- and post-test scores suggested the existence of differences between

* Paper presented at the twenty-seventh annual meeting of The National Association for Research in Science Teaching, Sherman Hotel, Chicago, Illinois, March 30, 1954. The study was carried out under Contract N8ONR-66213 with the Office of Naval Research. The writer wishes to express his appreciation to Prof. Wm. J. Moonan for outlining the computational procedures of the factorial experiment.

[1] Wall, C. N., Kruglak, H., and Trainor, L. E. H. "Laboratory Performance Tests at the University of Minnesota," *Am. J. Phys.*, 19:546–555, 1951.

[2] Kruglak, H., *Paper-Pencil Laboratory Achievement Tests in Physics*, Technical Report No. 6, ONR Project NR 153–148. Minneapolis: 1953. Physics Department, University of Minnesota.

boys and girls, between the students enrolled in the course with laboratory and those taking the same course without laboratory. It was also thought desirable to explore the effect of high school physics. Consequently, a factorial experiment was carried out with students enrolled in Physics 1 (without laboratory) and 1a (with laboratory).

### 2. FACTORIAL DESIGN FOR PAPER-PENCIL LABORATORY TESTS IN MECHANICS

An analysis of variance for each of the four laboratory pre- and post-tests in Mechanics was carried out according to a $2 \times 3 \times 3$ design shown in Table I.

TABLE I

A $2 \times 3 \times 3$ EXPERIMENTAL DESIGN FOR LABORATORY ACHIEVEMENT IN PHYSICS

| | Male | Female |
|---|---|---|
| Had high school | Physics 1 | Physics 1 |
| physics with lab. | Physics 1a | Physics 1a |
| Had high school | Physics 1 | Physics 1 |
| physics without lab. | Physics 1a | Physics 1a |
| Had no high | Physics 1 | Physics 1 |
| school physics | Physics 1a | Physics 1a |

An analysis of variance and covariance was also carried out on each of the four post tests with the effects of corresponding pre-tests held constant. A $2 \times 3$ design was used, with the factors of sex and high school background under consideration.

It was decided to accept differences as significant if they reached the one per cent level; differences at the five per cent level were to be considered as symptomatic of a trend in need of additional exploration.

### 3. DESCRIPTION OF THE TESTS

The criteria tests of this study were: *Identification of Apparatus, Function of Apparatus, Experiments,* and *Miscellaneous.* They consisted of multiple-choice, five alternative items based on pictures of apparatus commonly used in an elementary physics laboratory. A typical item from each of the tests is reproduced below.

*Identification item:*

Picture 26 shows a(an)

(a) rotary inertia apparatus, (b) Young's modulus apparatus, (c) centripetal force apparatus, (d) torsion apparatus, (e) Atwood's machine.

*Function item:*

The apparatus shown in Figure 11 is used to

(a) determine atmospheric pressure.
(b) measure altitude directly.
(c) determine water pressure.
(d) find absolute humidity.
(e) determine density of air.

*Experiments item:*

The set of apparatus shown in picture 4 (inclined plane and block of wood) is to be used in obtaining the data necessary for finding the coefficient of friction by the inclined plane method. To yield sufficient data the set of apparatus labeled No. 4.

(a) and items * W and X are necessary and sufficient

* W—triple beam balance; $\overline{X}$—micrometer; Y—stop watch; Z—meter stick.

(b) and items W and Y are necessary and sufficient
(c) and items W, Y, and Z are necessary and sufficient
(d) and item Z are necessary
(e) includes the minimum equipment necessary

*Miscellaneous item:*

The device shown in picture 2 (traveling microscope) is most appropriate for measuring dimension

(a) A, (b) B, (c) C, (d) D, (e) E

The writer will be glad to supply on request detailed data on the reliability and validity of the tests.

### 4. ANALYSIS OF DATA [3]

#### *A. Analyses of Variance of the Pre-tests*

From the analysis of variance for each of the pre-tests it was concluded that:

[3] The statistical Appendix is available on request from the author.

1. The hypothesis of no difference between sexes was *rejected* at the one per cent level for all the pre-tests.

2. The hypothesis of no interaction between the three factors was *rejected* for the Identification, Function and Miscellaneous pre-tests.

3. Different backgrounds in high school physics appeared to have some effect on the Identification and Function pre-tests.

*B. Analyses of Variance of the Post-tests*

From the analysis of variance for each of the post-tests it was concluded that:

1. The hypothesis of no difference between the sexes was *rejected* at the one per cent level for the Identification and Miscellaneous post-tests.

2. The hypothesis of no difference between those taking the course with laboratory and those taking no laboratory was *rejected* at the one per cent level for the Identification post-test.

3. The hypothesis of no interaction between the factors was *rejected* at the one per cent level for the Identification and Function post-tests.

*C. Analysis of Variance and Covariance of the Post-tests*

Since the analyses of variance of the pre-tests showed no significant differences between students in Physics 1 and 1a, the samples in the two courses were pooled for the analysis of variance and covariance. The effects of each pre-test were partialled out in the analysis of the corresponding post-test. It was concluded that:

1. The hypothesis of no difference between the sexes was *rejected* at the one per cent level for the Identification and Function post-tests.

2. Sex differences appeared to have some effect on the Experiments post-test.

3. The differences between students with various backgrounds in high school physics, if present, were probably of the same order of magnitude as the experimental errors.

*D. The Effect of Laboratory Instruction in High School Physics on Paper-pencil Tests in Mechanics*

The boys in Physics 1 and 1a were divided into four subsamples: high school physics with laboratory, high school physics without laboratory, high school physics, no high school physics. F-ratios and *t*-values were used in comparing the groups.

There was only one significant difference between the means: the subjects in Physics 1a with laboratory work in high school physics were superior to those without any high school physics on the Identification pre-test.

The general trend appeared to be that the differences were mostly apparent on the Identification and Function tests and primarily between the subjects with and without high school physics. Thus, laboratory instruction in high school physics appeared to contribute little to scores on paper-pencil laboratory pre- and post-tests in Mechanics.

*E. The Effect of Laboratory Instruction in High School Physics on Other Achievement Measures in College Physics*

The four subsamples in Physics 1a were also compared on the laboratory performance test,[4] laboratory grade, and final examination in the course.

The conclusions reached on the basis of the data were:

1. There was a statistically significant difference in the means of the laboratory performance test for students with high school laboratory and those without it, in favor of the laboratory group.

2. There were no significant differences between any pair of means on the average laboratory grade.

3. There were significant differences between the means of the group with high school physics laboratory and the one

[4] Kruglak, N., "Performance Tests in Physics at The University of Minnesota," *Science Education*, 37:108–121, March, 1953.

without high school physics on the final examination of the course. The high school physics-no high school physics difference between the means was also significant on the final examination. There was no difference between those who had physics with the laboratory and the no laboratory group.

It is difficult to explain why the differences between the means on the laboratory test should *not* be significant for the high-school-physics-laboratory and the no-high-school-physics comparison. More data will be needed to clear up this point. The final examination results show the expected hierarchy of performance in terms of background in high school physics, with the highest mean belonging to the group with the laboratory experience and the lowest mean characteristic of the group without high school physics. However, one must not discount the possibility of the students with interest in the subject and ability electing high school physics and also the possibility of better instruction in a high school physics course which offers laboratory.

## 5. SUMMARY AND CONCLUSIONS

A $2 \times 3 \times 3$ factorial design was used to ascertain the effects of high school physics, sex differences, and college laboratory on the scores of four laboratory paper-pencil tests in Mechanics. Students with varying backgrounds in high school were compared on the paper-pencil tests, laboratory performance tests, laboratory grades and final examinations.

It was found that:

(1) There were significant sex differences on the four pre-tests in Mechanics.

(2) There were significant sex differences on the Identification and Miscellaneous post-tests in Mechanics.

(3) There were significant sex differences on the Identification and Functions post-tests with the corresponding pre-test scores held constant.

(4) Students taking the college course with laboratory had significantly higher means on the Mechanics Identification post-test than students exposed to theory instruction only.

(5) Laboratory work in high school physics appeared to have little influence on the paper-pencil laboratory pre- and post-test scores in Mechanics.

(6) There was a tendency on the part of students with a high school physics background to have higher means on some of the paper-pencil tests than in the case of the no-high-school-physics samples. The latter groups appeared to have less consistent pre-post gains.

(7) Students with laboratory experience in high school physics had significantly higher means on the laboratory performance test in Mechanics than the students without such experience.

(8) The laboratory background in physics appeared to have no effect on the average laboratory grades and on the final examination scores for all the samples of the study.

(9) Students with high school physics had a significantly higher means on the final examination in Mechanics than the group without.

(10) One can not exclude the probability of students with interest and ability in physics electing the course in high school and thus introducing a bias into the factors of the investigation.

# CURRICULUM TRENDS IN CITY SCHOOL SYSTEMS *

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To discuss, even briefly, the curriculum trends in city school systems consideration must be given to three definite factors:

Observable trends of the science curriculum.
Science in a city such as Chicago for purposes of illustration.
The science program.

Trends currently observed in curriculum programs of cities of large and medium size include:

a. Development of city-wide philosophy and objectives relating curriculum to daily living
b. Making the individual school the primary unit of curriculum improvement, utilizing central-office procedures as a pattern or guide
c. Wide representation of school and community personnel in curriculum planning
d. Increasing emphasis on *pupil behavior* as a test of curriculum success
e. Broadening of established *subject fields* as a means of relating curriculum to daily living
f. All areas of pupil living—school, home, community—are utilized in curriculum development
g. Inservice training program in curriculum principles and practices
h. Co-operation between central office and the individual school
i. Principal is indicated as the leader of curriculum and instruction improvement in his school and community

Processes illustrative of the foregoing trends have been utilized in the Chicago program of curriculum development as follows:

a. Formation of a Curriculum Council, consisting of representative school and lay personnel who formulate city-wide objectives
b. Scope of curriculum outlined in Nine Major Functions of Living:
Practicing American citizenship
Using the tools of communication
Developing economic competence
Improving family living
Protecting life and health
Building human relationships
Enjoying wholesome leisure
Satisfying spiritual and aesthetic needs
Meeting vocational responsibilities

These nine major functions have been analyzed into essential pupil activities or experiences which form main source materials at each of six levels of pupil development, namely:

1. Infancy (Preschool; below 5 years)
2. Early Childhood (Kindergarten-Primary; 5 to 7 years)
3. Later Childhood (Grades 3 to 5; 8 to 10 years)
4. Early Adolescence (Grades 6 to 8; 11 to 13 years)
5. Adolescence (Grades 9 to 12; 14 to 17 years)
6. Early Adulthood (Junior College)

c. *Pilot schools* have been established at elementary, secondary and junior-college levels to develop and evaluate newer patterns of curriculum development
d. *Framework committees* work at the various levels to determine the administrative organization that best provides a program to implement Curriculum Council objectives
e. *Pupil-behavior* objectives have been developed by nine psychologists serving pilot schools, through making analyses of the major-function lists of activities and of data on the nature of children and youth. A tentative list of ten pupil-personality objectives or "developmental goals" has been formulated as follows:
To develop and maintain emotional stability
To develop critical thinking at child's developmental level
To develop a sense of security
To develop self-direction
To develop an acceptance of realistic standards
To develop co-operative attitudes
To develop a sense of responsibility
To develop social effectiveness
To develop creative satisfactions
To develop reasonable acceptance of authority at child's developmental level.
f. Patterns for units of learning have been developed by which the major functions' activities of living are translated into classroom learning experiences.
g. Curriculum guides for each subject field, kindergarten through junior college, are being developed by representative curriculum committees to give teachers a comprehensive overview of the basic requirements of the fields of general education.

* Paper presented at the twenty-seventh annual meeting of the National Association for Research in Science Teaching, Sherman Hotel, Chicago, Illinois, March 29, 1954.

h. The chief medium for inservice training consists of sound filmstrips of units carried out in pilot and associated schools, showing the complete development of a unit from basic source lists of activities to culmination in daily living.
i. Leadership in the total program by the principal is implemented through central office aids and resources.

How a subject field is utilized to make a significant contribution to the curriculum is illustrated by the procedures utilized in developing the science curriculum of the Chicago Public Schools.

a. Science utilized as a part of the general curriculum for all pupils
b. General courses supplemented by specialized, elective field—for selected pupils at high-school level
c. Activities of major functions indicated for science classified in a single list for that subject field, at each level of pupil development
d. Units of learning based on subdivisions of major function lists, which recur at increasing maturity levels. Many of the units are integrated with other subject fields and learning areas.
e. A curriculum guide for the complete science program is being developed by a committee of school administrators, science teachers, university specialists, and industrial leaders working in coordination with similar committees for social studies, language arts, and other general-education fields. Attention is given to vertical continuity and horizontal coordination in a curriculum realistically related to daily living.

## WALTER CLYDE CROXTON

IT is with regret that we report the passing of Walter Clyde Croxton on November 25, 1954. Professor Croxton passed away suddenly from a heart attack at his summer home at Pine Point, Minnesota. The night before his death, he was working on plans for a new research project in science teaching. Survivors include his wife Nora Ellen Geeting whom he married in 1917, a daughter Mrs. Ralph Valenta (Mildred) of East Detroit, Michigan, three grandchildren, and two brothers, Harry Croxton of Rushville, Illinois and Everett Croxton of Springfield, Illinois. He was a member of the Unitarian Church.

Professor Croxton was born at Pleasant View, Illinois, October 6, 1894. He had B.S. (1921) and M.S. (1923) degrees from the University of Illinois. Teaching experience included rural school at Salem, South Dakota, 1912–13; Superintendent at Bardolph, Illinois, 1914–15; Holly Colorado High School, 1915–16; Supervisor, Rock Island Public Schools, 1918–20; Urbana Illinois High School, 1920–21; Supervisor of Practice Teaching University of Illinois, 1921–25; College of Liberal Arts and Sciences, University of Illinois, 1925–27; State Teachers College, St. Cloud, Minnesota, 1927–54; Summer Session Ohio State University, 1940 and 1941; Summer Session University of Minnesota, 1946. For many years he had been professor of biology and Chairman of the Division of Mathematics and Sciences at St. Cloud. He was a past president of the Minnesota Academy of Science.

Membership in organizations included NARST, NEA, MEA, Minnesota Academy of Science, AAAS, NSTA, NABT, Phi Delta Kappa, Kappa Delta Pi, AAUP, Phi Sigma, Sigma Xi.

Some twenty-four of Professor Croxton's publications are found in *School Science and Mathematics, Proceedings of the Illinois High School Conference, Ecology, Minnesota Horticulturist, Proceedings of the Minnesota Academy of Science, Ohio State University Workshop Proceedings, The Conservation Volunteer, Western Illinois State College Bulletin, National Council of Elementary Science News Notes,* and *Science Education.* The latest of Professor Croxton's publications is found in the February 1955 issue of *Science Education.*

Professor Croxton's best known and widely used publication is his textbook *Science In The Elementary School,* published by McGraw-Hill Book Company.

# A REPORT TO THE NARST ON THE ACTIVITIES OF THE COOPERATIVE COMMITTEE OF THE AAAS FOR 1953–54

GEORGE GREISEN MALLINSON *

*Western Michigan College, Kalamazoo, Michigan*

## MEMBERSHIP

THE membership of the Cooperative Committee on the Teaching of Science and Mathematics of the AAAS for 1953–4 consists of representatives of eighteen different organizations concerned with the teaching of science and mathematics.

The member societies and their representatives are these:

American Association of Physics Teachers: Bernard B. Watson, (Secretary), Operations Research Office, Johns Hopkins University
American Astronomical Society: Thornton Page, Operations Research Office, Johns Hopkins University
American Chemical Society: C. H. Sorum, University of Wisconsin
American Geological Institute: Arthur L. Howland, Northwestern University
American Institute of Physics: J. W. Buchta, University of Minnesota
American Nature Study Society: Richard L. Weaver, University of Michigan
American Society for Engineering Education: Milton O. Schmidt, University of Illinois
American Society of Zoologists: L. V. Domm, Loyola University, Chicago
Botanical Society of America: Glenn W. Blaydes, Ohio State University
Central Association of Science and Mathematics Teachers: Donald W. Lentz, Parma (Ohio) Public Schools
Division of Chemical Education of the American Chemical Society: Laurence L. Quill, Michigan State College
Executive Committee of the AAAS: Duane Roller, Hughes Aircraft Company
Mathematical Association of America: J. R. Mayor, University of Wisconsin
National Association of Biology Teachers: Prevo L. Whitaker, Indiana University
National Association for Research in Science Teaching: George G, Mallinson, Western Michigan College
National Council of Teachers of Mathematics: George E. Hawkins, Lyons Township High School and Junior College, LaGrange, Illinois
National Science Teachers Association: Morris Meister, (Chairman), Bronx High School of Science
Section Q (Education), AAAS: Francis D. Curtis, University of Michigan

* NARST Representative on the Cooperative Committee.

Since the last meeting on May 23 and 24, 1953, several members have been replaced. It has been stated unofficially that Francis D. Curtis, Donald W. Lentz and John R. Mayor are among those replaced. However, until official confirmation is made at the next meeting on April 3 and 4, 1954, their replacements cannot be announced.

## MEETINGS

It has been the general policy of the Cooperative Committee to hold two meetings per year, one in the spring and one in the fall. The spring meeting is ordinarily held in the Midwest, generally at one of the large colleges or universities. In 1953 this meeting was held on March 23 and 24 at Western Michigan College, Kalamazoo, Michigan.

The fall meeting is ordinarily held in Washington, D. C., in conjunction with certain science and mathematics programs of the Office of Education. However, the fall meeting was not held in 1953, since the Specialist in Science, through whom arrangements were ordinarily made, had resigned. Further, the new Commissioner of Education, Dr. Thurston had died shortly before the time for the meeting and the invitations to the joint meeting were ordinarily issued through that office.

## ACTIVITIES FOR THE YEAR 1953–4

### *Regular Meetings*

In the opinion of your representative the Cooperative Committee did not, during the last year, come to grips with the major issues in science education that seemed to be within its province. This, no doubt, was due in a large measure to the cancellation of the fall meeting. At the Kalamazoo meeting the following items were on the agenda.

*a. Youth with Potential in Science and Mathematics*

This topic again absorbed the major portion of the time of the Committee at the Kalamazoo meeting. A number of new publications were discussed, the Ford Foundation experiments with talented youth were reviewed, provisions for educating talented students in the area of science and mathematics were again debated, and services of professional organizations for these youth were brought before the Committee.

In general the Committee approved of the objective of educating talented youth to the fullest of their potentials. However, it seemed to be the concensus that this topic had been raised sufficiently frequently, and the Committee had gone to the maximum in its implementation.

*b. Teaching of Science in Secondary Schools*

Three projects dealing with the improvement of science teaching in the schools were discussed. One concerned the four-week conference on science teaching at Harvard University during the summer 1953, the second with certain activities of the Future Scientists of America Foundation, and the third with a project suggested by Teachers College, Columbia University.

The Cooperative Committee strongly supported all efforts in the area mentioned. However, in general the Committee declined to endorse any one project since the scope of the projects was so vast. It was believed that the Cooperative Committee, representing many organizations, should avoid endorsing activities controlled by one group but ramifying widely into the activities and programs of many. The following quotation from the minutes expresses this viewpoint.

"The Committee heartily approves the objective of the project which is to improve the teaching of science in the secondary schools in the interest of meeting the national need for scientific manpower. The Committee raised several questions, however, about the desirability of endorsing the specific project which is outlined in the . . . prospectus.

. . . hopes to accomplish its project through the financial support of industry, professional associations, and foundations. Since several institutions and professional associations are already seeking this type of financial support for similar projects, it would seem unwise to encourage further efforts along these lines by individual. . . . With the establishment of the Scientific Manpower Commission, it seems more desirable to us that efforts of this sort be coordinated through the Commission.

In a project of the scope contemplated, involving a number of educational institutions, the Cooperative Committee would also prefer to see the general direction of the project and the determination of overall policies under the control of a group such as the Scientific Manpower Commission rather than a single. . . .

The Cooperative Committee felt, in addition, that it would be unwise to endorse a project at a state in which the policies and operating procedures to be followed are still largely undetermined and are left to later decisions in which the Committee will not participate. It feels that considerably more detail is needed to indicate clearly the way in which the improvement of science teaching is to be achieved."

Your representative strongly supports this policy.

*c. Activities of the Representative Societies*

Some time was spent describing the institutes and projects undertaken by the member societies. These included (1) the summer meeting of the American Association of Physics Teachers, (2) the institutes and workshops on the teaching of mathematics fostered by the National Council of Mathematics Teachers and Mathematical Association of America, (3) the publication for the elementary school teachers being developed by the National Council of Teachers of Mathematics, (4) the joint meetings of the science teaching societies affiliated with the AAAS, and (5) the activities of the Committee of Secondary Schools, American Society for Engineering Education in the field of high school—college articulation and in the improvement of high school teaching in mathematics. It was suggested that the societies represented on the Cooperative Committee give publicity and support to these events and activities when possible.

*d. Courses in Mathematics, Biology, Chemistry and Physics as proposed by the Committees of the School and College Study of Admission with Advanced Standing*

The Cooperative Committee was divided into subcommittees for the

". . . purpose of reviewing the science courses developed in connection with the School and College Study of Admission with Advanced Standing. Each of the subcommittees prepared a report covering its comments and recommendations in connection with the course prospectus which it reviewed. . . ."

In general the various subcommittees expressed these opinions:

1. The courses would be suitable only for the most able of students and in schools in which the most exceptional of laboratory facilities are available.

2. There was some question as to whether the courses were really equivalent to the respective first-year courses in college and as to whether the coverage of topics might not be somewhat cursory.

3. Most of the courses seemed to emphasize factual attainments rather than scientific and mathematical understandings.

4. Only the best teachers in a school system could be used to handle these courses. There was some question as to whether the use of the best teachers with small numbers of students results in efficient use of staff, particularly in light of the present shortage of teachers in science and mathematics.

Your representative is of the opinion that programs for the education of talented youth involve more than the development of course structures. Yet these other factors seem to be given little consideration in these programs.

*e. Projected Activities*

A number of suggestions were made for future activities. One dealt with a request of the Board of Directors of the AAAS to take leadership in resolving the controversy between subject-matter specialists and educators. It was thought that this might well be the theme for the fall meeting with the Office of Education.

Another dealt with a possible joint symposium with school administrators on the general theme of teaching conditions in science and mathematics. The National Association of Secondary School Principals was amenable to the proposal.

Neither of these proposals were implemented during the year.

## The Boston Meeting of the AAAS

The Cooperative Committee again participated in the Sixth Annual Joint Conference of the Science Teaching Societies affiliated with the American Association for the Advancement of Science. The meetings were held on December 26–31, 1953, at the Hotel Bradford, Boston, Massachusetts.

The Cooperative Committee and Section Q of the AAAS jointly sponsored the *Symposium: The Next Generation of Young Scientists and Their Science Teachers.* The symposium dealt with the roles of the single-track and double-track systems in science and mathematics in public schools for training future scientists, and also with the Harvard Conference already mentioned.

In addition the Cooperative Committee co-sponsored sessions entitled *New Developments from Research in Resources of the Land* and *New Developments from Research into Resources of Water.*

Unfortunately the ANSS and NABT have withdrawn from the joint meetings to be held at the AAAS Convention at Berkeley, California, in December 1954. However, the withdrawal was stated as being for one year only. Whether or not the joint meetings will be reinstituted at a later date is still a matter of conjecture.

## The Future of the Cooperative Committee

In the opinions of many of the representatives on the Cooperative Committee, the administrative and operating structures of the Committee need modification. This is a logical concomitant of the natural evo-

lution of the functions of the Committee. The activities of the Committee now ramify widely into many of the major areas of science and mathematics education of interest to the professional societies represented on the Committee. Hence broader representation in developing and implementing programs and policies for the Committee seems desirable.

Hence your representative has presented the following proposals for study by the Cooperative Committee at its meeting on April 3 and 4 in Chicago, Illinois.

1. That the Cooperative Committee work more closely with the AAAS in deciding which activities it should undertake.

2. That the Cooperative Committee establish an Executive Committee consisting of three members who shall be responsible for preparing the program. The members of this group should be appointed for a three-year period and selected on the basis of the alphabetical positions of their societies on the stationery. Every year the person nearest the beginning would be dropped and a person near the end added. These persons would be expected to consult the various members of the Committee in order to determine the type of program that is most acceptable and feasible.

3. That there be two Executive Officers of the Committee rather than one—a Chairman and a Vice-Chairman. The Chairman would be restricted to a *maximum* of two consecutive terms in office. The Vice-Chairman might well succeed the Chairman. In this way there would be a continuity in the executive leadership.

Neither the Vice-Chairman nor the Chairman would be a member of the Executive Committee, but should be selected from representatives of other societies.

4. That the major portion of our next meeting be devoted to (a) an evaluation of exactly what has been accomplished over the last three years, (b) a determination of those areas which the Committee may drop from discussion, and (c) a listing of those important areas which logically fall within the realm of the activities of the Cooperative Committee.

It is hoped that adoption of these proposals will enable the Committee to handle its evolving functions more efficiently and democratically.

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## NORTH CENTRAL CONFERENCE ON BIOLOGY TEACHING TO BE HELD AT UNIVERSITY OF MICHIGAN BIOLOGY STATION

A North Central Conference on Biology Teaching sponsored by the National Association of Biology Teachers on a grant from The National Science Foundation, will be held at the University of Michigan Biological Station at Douglas Lake, Cheboygan, Michigan, August 19–30, according to Brother Charles H. Severin, President of NABT, St. Mary's College, Winona, Minnesota.

Ninety delegates will be selected from high schools, colleges and state departments of education in Michigan, Ohio, West Virginia, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri and Kansas.

The staff selected for the Conference includes Dr. Richard L. Weaver, as Director, University of Michigan, Ann Arbor, Michigan; Dr. John Breukelman as Chairman of the Steering Committee, State Teachers College, Emporia, Kansas; Dr. Richard R. Armacost, Purdue University, West Lafayette, Indiana; Paul Klinge, Howe High School, Indianapolis, Indiana; and Dr. Alfred H. Stockard, Director of the University of Michigan Biological Station, Ann Arbor, Michigan.

This is the second conference sponsored by NABT and The National Science Foundation. The Report of the Southeastern Conference held in 1954 at the University of Florida, was published as the January issue of *The American Biology Teacher*.

# *SUMMARY OF THE PRESENTATION AND PANEL* ON CURRENT TRENDS IN EDUCATION AND IMPLICATIONS FOR RESEARCH IN SCIENCE EDUCATION

ABRAHAM RASKIN, Co-Chairman

*Educational Trends—Atomic Energy Committee, Hunter College, New York, New York*

*Trends suggested by the Major Speakers*

*Dr. Johnson*

1. The cooperation of all the elements of a community including labor, industry, parents, teachers, school administrators, citizens in general, and children in curriculum study, revision and experimentation

2. The realization that the dynamic for school improvement lies at the local level

3. The trend towards familiarizing the public and all the teachers with the entire school program

*Dr. Pierce*

1. The "broadening" of individual subject matter fields (as opposed to the adoption of unified or core programs)

2. New and better in-service programs to acquaint teachers with changes in the curriculum

3. The use of pilot schools for curriculum experiments

4. The development of curriculum guides to acquaint as many teachers as possible with all aspects of the curriculum

5. The use of so-called "activities of living" in the formulation of curricula

6. The development of general education programs in high school science

*Dr. Tyler*

1. The continuing increase in man's knowledge; the pushing back of the frontiers of science

2. The continuing increase in the public school population

3. The increased demands being made on the public schools

4. The raising of the level of acceptable literacy

5. Improved application of our knowledge of the educative process, of learning, and of group dynamics

6. The increase in the number and percentage of children leaving high school prior to graduation

7. The increasing use of "demands of society" in the revision and formulation of school programs

8. The changing concept of the meaning of science

9. The re-examination of the role of the school in educating our youth (as distinguished from the role of the home, of the job, and so forth)

10. The increased recognition of the role and importance of evaluation

11. The increasing amount of research on the identification of the gifted youth and how he should be educated.

*Trends examined by Members of the Panel and the Audience*

1. How are the elements of the community listed by Dr. Johnson used in the formulation of science curricula on the secondary and college levels? What research is needed in this area?

2. In view of the continually retreating frontiers of science, how are we to decide what to include in our science courses at the various levels? What kinds of research will enable us to make intelligent selections involving areas to cover, depth, breadth, and so forth? Does not this trend point up the need for more and better general education programs in science?

3. How are we to determine with a high degree of validity how to grade place the development of certain concepts in the elementary school?

*Suggestions for an NARST Educational Trends Committee Program for 1955*

*Topic:* How can the preparation of the elementary school teacher in the teaching

of science be improved? What research is needed in this area?

*Speakers:* A person involved in the preservice education of elementary school teachers; a person involved in the in-service training of elementary school teachers, e.g. an assistant superintendent or elementary school principal particularly interested in science teaching; and a science consultant

*Report:* On a questionnaire on this topic submitted to a fairly large group of elementary school teachers

## 1954 ELECTED MEMBERS OF NARST

Arthur John Baker
72 McHenry Avenue
Crystal Lake, Illinois

Louis Thomas Cox, Jr.
6700 Sherwood Road
Baltimore 12, Maryland

Warren Maywood Davis
North Plainfield High School
North Plainfield, New Jersey

James W. Gebhart
4926 Donald Avenue
Cleveland 24, Ohio

Milton Hopkins
Editor-in-Chief, School Department
Henry Holt and Company
383 Madison Avenue
New York, New York

Paul De H. Hurd
School of Education
Stanford University
Stanford, California

Hugo E. Lahti
327 West Ann Street
Whitewater, Wisconsin

Chester Alvin Lawson
Basic College
Department of Natural Sciences
Michigan State College
East Lansing, Michigan

Jacqueline V. Buck Mallinson
535 Kendall Avenue
Kalamazoo, Michigan

William E. Merrill
306–6th Avenue
Radford, Virginia

Grace Parle
3542 Russell
St. Louis, Missouri

James Perlman
San Francisco State College
San Francisco, California

Albert Piltz
School of Education
University of Florida
Gainesville, Florida

Lyle L. Radcliffe
Faculty Apartments
State Teachers College
Wayne, Nebraska

Rufus D. Reed
New Jersey State Teachers College
Montclair, New Jersey

James A. Rutledge
Room 112 Teachers College
University of Nebraska
Lincoln, Nebraska

Alfred A. Silano
196 Rutgers Street
New Brunswick, New Jersey

Milton F. Tostlebe
Northern State Teachers College
Aberdeen, South Dakota

Leland L. Wilson
Box 295
Georgia Teachers College
Collegoboro, Georgia

Finley Carpenter
Board of Examiners
Michigan State College
East Lansing, Michigan

Ruth E. Cornell
1806 Van Buren Street
Wilmington, Delaware

M. Ira Dubins
81 Rangeley Road
Chestnut Hill, Massachusetts

Everett F. Evans
701 Riverside Drive
Fort Worth, Texas

Frank Gorner
Manchester University
Manchester, England

Velma F. Huntley
Johnson Teachers College
Johnson, Vermont

William Harrison Lucow
Suite 12, Stratford Hall
285 College Avenue
Winnipeg, Manitoba, Canada

Robert Douglas MacCurdy
126 Windsor Avenue
Watertown, Massachusetts

Steven J. Mark
403 Wolcott
Kent, Ohio

Harry Milgrom
New York City Board of Education
110 Livingston Street
Brooklyn, New York

# Program
OF THE
# TWENTY-SEVENTH ANNUAL MEETING
OF
# The National Association
FOR
# RESEARCH IN SCIENCE TEACHING
HOTEL SHERMAN
CHICAGO, ILLINOIS
MARCH 29–31, 1954

## OFFICERS OF NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

*President:* DR. GEORGE G. MALLINSON,
Departments of Psychology and Education,
Western Michigan College of Education,
Kalamazoo, Michigan

*Vice-President:* DR. KENNETH E. ANDERSON,
School of Education,
University of Kansas,
Lawrence, Kansas

*Secretary-Treasurer:* DR. CLARENCE M. PRUITT,
304 Walnut Street,
Stillwater, Oklahoma

*Executive Committee:* DR. WILLIAM C. VAN DEVENTER,
Department of Biology,
Western Michigan College of Education,
Kalamazoo, Michigan;
DR. J. DARRELL BARNARD,
School of Education,
New York University,
New York, New York

## SUNDAY, MARCH 28, 1954

7:30 P.M. Meeting of Officers, Executive Committee and Committee Heads
*Polo Room #102*

## MONDAY, MARCH 29

*Crystal Room*

### PROGRAM FOR GRADUATE STUDENTS AND MEMBERS

Presentation and Discussion of Research Studies in Progress
GEORGE GREISEN MALLINSON, *Chairman*

9:30–10:00 Registration and Greeting

10:00–10:25 Factors Influencing the Choice of Scientific Hypotheses By College Freshmen.
Zylpha D. Hurlbut, Chairman, Biology Dept., Anderson College, Anderson, Indiana (New York Univ.)

10:25–10:50 A Proposed Investigation of the Secondary Science Teacher Education Programs in a Selected Group of Colleges and Universities.
Archie L. Lacey, Instructor in Science, Alabama State College, Montgomery, Alabama (Northwestern U.)

10:50–11:15 The Synthetic Development of a Course in General Physical Science For Secondary Schools.
Jacqueline V. Buck, Instructor in Science, Grosse Pointe Public Schools, Grosse Pointe, Michigan (University of Michigan)

11:15–11:40 The Status of Science Instruction in the One-Teacher Schools of Four Selected Counties of Minnesota.
Harry H. Goehring, State Teachers College, St. Cloud, Minnesota (University of North Dakota)

11:40–12:00 Summary and Recommendations
Dr. Hanor A. Webb, Prof. Emeritus of Chemistry and Science Education, George Peabody College for Teachers, Nashville, Tennessee.

1:30–3:30

Welcome—George G. Mallinson, President, NARST

CURRENT TRENDS IN EDUCATION AND IMPLICATIONS FOR RESEARCH IN SCIENCE EDUCATION

Prepared by the NARST Committee on Educational Trends—Atomic Energy

Part I Current Trends in Education (Presentation)
Chairman: Jerome Metzner, Chairman, Dept. of Biology, Bronx High School of Science, New York City
Speakers: Eric H. Johnson, University of Illinois, Assoc. Director, Illinois Curriculum Program; Paul R. Pierce, Asst. Superintendent, Instruction and Guidance, Board of Education, City of Chicago; Ralph W. Tyler, Director, Center for Advanced Study in the Behavioral Sciences

Part II Implications for Research in Science Education (Panel Discussion)
Chairman: Abraham Raskin, Teacher Education Program, Hunter College, New York City
Panel Members: John H. Woodburn, Asst. Executive Secretary, National Science Teachers Association; Hubert M. Evans, Prof. of Natural Sciences, Teachers College, Columbia University, New York City; Edward C. Fuller, Chairman, Dept. of Chemistry, Beloit College, Beloit, Wisconsin; Jerome Metzner, Bronx High School of Science; William B. Reiner, Research Asst., Bureau of Educational Research, Board of Education, New York City

Part III General Discussion

MEETINGS OF COMMITTEES

(*All members of NARST and guests are welcome to attend any meeting.*)

| 7:15 P.M.–9:00 P.M. | Room |
|---|---|
| Educational Trends—Atomic Energy Committee | 102 |
| Problem Solving Committee | 108 |
| Liaison Committees (NSTA, Advisory Committee to Office of Education) | 110 |
| Reserved for special committee meetings that may be requested | 111 |

TUESDAY, MARCH 30

*Crystal Room*

PROGRAM OF RESEARCH PAPERS

J. DARRELL BARNARD, *Chairman*

9:15– 9:45 A Comparison of the Biology Interests of Tenth and Eleventh Grade Pupils with a Topical Analysis of High School Biology Textbooks.
Sam S. Blanc, East High School, Denver, Colorado

9:45–10:15 A Study of the Opinion of Students on College General Education Science.
Thomas P. Fraser, Morgan State College, Baltimore, Md.

10:15–10:45 The Identification and Evaluation of Principles of Soil and Water Conservation for Inclusion in the Secondary School Curriculum.
Harry F. Glidden, Colorado State College of Education, Greeley, Colorado

10:45–11:15 An Analysis of Principles and Activities of Importance for General Biology Courses in High Schools.
Margaret J. McKibben, Oak Park and River Forest High School, Oak Park, Illinois

11:15–11:45 Principles as Guides to the Selection of Materials and to the Teaching of Earth Science for All Youth in the Secondary School.
Loren T. Caldwell, Northern Illinois State Teachers College, DeKalb, Illinois

PROGRAM OF RESEARCH PAPERS

WILLIAM C. VAN DEVENTER, *Chairman*

1:30– 1:55 Competencies Desirable for Beginning Science Teachers As Viewed by Administrators and Science Teachers in the State of Illinois.
T. A. Nelson, LaGrange, Illinois

1:55– 2:20 A Study of the Use of Sound Motion Pictures in High School Biology.
Kenneth E. Anderson, Fred S. Montgomery and Herbert A. Smith, University of Kansas, Lawrence, Kansas

2:20– 2:45 Lectures Versus Problem-Solving in Teaching Elementary Soil Science.
Murray D. Dawson, Dept. of Agronomy, Cornell University, Ithaca, New York

2:45– 3:10 The Effect of High School Physics and College Laboratory Instruction on Achievement in College Physics.
Haym Kruglak, Dept. of Physics, University of Minnesota, Minneapolis, Minnesota

3:10– 3:35 The Organization, Installation, Implementation, and Administration of A Course in Physical Science Designed for General Education.
Cleveland J. Franks, Morgan State College, Baltimore

3:35– 4:00 Planning a Student Teaching Program for Prospective High School Science Teachers.
Ralph L. Beck, Bowling Green University, Bowling Green, Ohio

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*Polo Room #102*

7:30 P.M.–10:00 P.M.

MEETING OF ALL LEVEL COMMITTEES (ELEMENTARY, SECONDARY AND COLLEGE) TO PREPARE REVIEW OF SCIENCE EDUCATION RESEARCH

KENNETH E. ANDERSON, *Chairman*

*All members of these committees are urged to attend. This is the big project.*

WEDNESDAY, MARCH 31

*N A R S T* Day

*Crystal Room*

10:00–10:50 Report of Project on Review of Science Education Research (Elementary, Secondary, College, Problem-Solving Committees).
Kenneth E. Anderson and Chairmen

10:50–11:00 Report of Educational Trends—Atomic Energy Committee
Abraham Raskin and Jerome Metzner

11:00–11:10 Report of Liaison Committees
NSTA—Clarence Boeck
Advisory Committee to Office of Education—Waldo Blanchet

11:10–11:20 Report on Cooperative Committee
George G. Mallinson

11:20–11:30 Report of Secretary-Treasurer
Clarence M. Pruitt

11:30–12:00 Action on Affiliation and Participation with AAAS.

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12:30 P.M. LUNCHEON

*Old Chicago Room*

Speaker: Dr. Joseph Pinsky, Armour Research Foundation: "Rockets and Jet Propulsion Today and Their Future Possibilities—A Layman's Approach."—Introduced by William C. Van Deventer.

## NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

### FINANCIAL REPORT—MARCH 31, 1954

#### RECEIPTS

| | |
|---|---|
| Balance on Deposit | $ 302.59 |
| Membership Fees | 1,527.00 |
| Total | $1,829.59 |

#### EXPENDITURES

| | |
|---|---|
| Bank Charges | $ 3.50 |
| Curtis Reprints for U. S. Office of Education | 22.27 |
| National Conference for Cooperative Health Education Dues | 15.00 |
| Mallinson Expenses—Paper, Envelopes, Mailing | 72.71 |
| Dinners for Lt. Colonel D. A. Heaton and Assistant | 10.50 |
| Dinners for Joseph Pinsky and Assistant | 7.00 |
| Placing Extra Microphones—Hotel Sherman | 15.80 |
| Joseph Pinsky—Dinner Speaker | 25.00 |
| Science Education Subscriptions | 1,065.00 |
| Total | $1,236.78 |
| Balance | $ 592.81 |

Respectfully submitted,
CLARENCE M. PRUITT
Treasurer—NARST

# OFFICIAL MINUTES OF THE BUSINESS MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

## Hotel Sherman, Chicago, Illinois

## March 31, 1954

PRESIDENT GEORGE G. MALLINSON presided at the annual business meeting of the National Association for Research in Science Teaching held in the Crystal Room of the Hotel Sherman. The official minutes of the last business meeting held at Atlantic City, New Jersey, February 17, 1953, were approved as published in the March 1954 issue of *Science Education.*

The report of the Auditing Committee of the Treasurer's book was made by Ira C. Davis, Chairman. Other members of the committee were John H. Jensen and Ralph W. Tyler. The chairman reported the Treasurer's book had been audited and found to be in balance. The report was accepted and is published in this issue of *Science Education.*

The report of the Nominating Committee was made by Clarence H. Boeck, Chairman. Other members of the Nominating Committee were Herbert A. Smith and Hubert M. Evans. The Nominating Committee presented the following list of officers for 1954–55:

President: KENNETH E. ANDERSON
Vice President: WILLIAM C. VAN DEVENTER
Secretary-Treasurer: CLARENCE M. PRUITT
Executive Committee: GEORGE G. MALLINSON, W. W. E. BLANCHET

Nominations from the floor were called for. It was moved and seconded that the report of the Nominating Committee be accepted and that the Secretary be empowered to cast a unanimous ballot for those named by the Nomination Committee. The motion carried.

Dr. George G. Mallinson, NARST representative on the Cooperative Committee on the Teaching of Science and Mathematics of the AAAS, made a report on the activities of that committee during the year. (See complete report in this issue of *Science Education*). It was moved and carried that report be accepted as presented. A report was made by Dr. Philip G. Johnson of the U. S. Office of Education relating to the compilation and digesting of research studies made available to the U. S. Office of Education. A motion was made and carried that the Executive Committee of NARST write to Dr. Brownell of the U. S. Office of Education expressing the hope that the position of Specialist for Secondary Science in the U. S. Office of Education be filled by appointment of some capable person as soon as feasible.

A report was made by Dr. Abraham Raskin on the work of the Educational Trends—Atomic Energy Committee. It was moved and seconded that the report be accepted.

Affiliation with the American Association for the Advancement of Science was discussed at some length by Dr. Mallinson, John A. Behnke, AAAS representative, and others. Members were in favor of such an affiliation and hoped that such affiliation would be favorably acted upon by AAAS officials.

Reports were made by the various level chairmen of Review of Science Education Research. Plans were made to publish the Second Annual Review in the December, 1954 issue of *Science Education.*

A list of members recently elected to membership in NARST were read as published in this issue of *Science Education.* The list was approved. The Executive Committee was asked to make as much data as possible available to members at the time new members are voted on. Better

and more critical evaluation needs to be made by the Executive Committee on persons proposed for NARST membership.

The Secretary reported the recent deaths of Dr. Archer W. Hurd, former President of NARST, and Mrs. W. L. Eikenberry. The secretary moved that he be empowered to convey to Mrs. Hurd and family and to Mr. Eikenberry respectively the heartfelt sympathy of the organization on the passing of Dr. Hurd and Mrs. Eikenberry. Motion carried.

The Secretary called to the attention of the members that Drs. Hanor A. Webb and Francis D. Curtis were now eligible for life membership in NARST. He made a motion that Professors Francis D. Curtis and Hanor A. Webb be made life members of NARST. Motion carried. It was announced that NARST had accepted a gracious invitation from Teachers College, Columbia University to hold its 1955 annual meeting at Teachers College. The tentative date is April 18–20, 1955.

A motion was made and carried that the 1954 business meeting be adjourned.

### Executive Committee Meeting
March 28, 1954
Hotel Sherman, Chicago

Members present were Mallinson, Pruitt, Barnard, and Van Deventer.

The Executive Committee discussed a number of pertinent matters. The NARST financial situation seems to be quite satisfactory. Affiliation with AAAS was discussed at some length and seemed to be most desirable from the standpoint of NARST if and when approved by the AAAS. NARST would have an official representative working with AAAS representatives. There seem to be many advantages of such an affiliation.

There was some discussion of the value of membership in the National Health Association. More information is needed as to potentialities for NARST of such membership. It was moved and carried that the President appoint a committee of two to investigate the desirability of such affiliation.

Professors Anderson and Smith reported good progress on the Review of Science Education Research.

The Committee discussed possible meeting places for the 1955 meeting and especially the invitation from Teachers College, Columbia University, to hold the 1955 meeting at Teachers College. NARST has never held its annual meeting on a college campus. It was decided to hold the 1955 meeting at Teachers College with the understanding that such a meeting place was not to be taken as indicative of future meeting places. Meeting adjourned.

### Dinner Meeting

Fifty-two members and guests attended the annual Dinner Meeting. Members present included: W. C. Croxton, George G. Mallinson, Kenneth E. Anderson, Wm. C. Van Deventer, W. W. E. Blanchet, Jacqueline Buck, Herbert A. Smith, Archie MacLean, F. Olin Capps, Sam Blanc, Don Decker, George T. Davis, Haym Kruglak, Paul De Hurd, Wm. F. Goins, Jr., Nelson L. Lowry, Grace Maddux, Edward K. Weaver, George M. Rawlins, N. Eldred Bingham, Thomas Wayne Taylor, Abraham Raskin, Stanley B. Brown, William W.. Rasor, Annie Sue Brown, Harley Glidden, Philip G. Johnson, Hubert M. Evans, Thomas P. Fraser, Milton O. Pella, Harold E. Wise, Nathan Neal, Hubert B. Crouch, Betty Lockwood Wheeler, Clarence H. Boeck, Greta Oppe, Cyrus W. Barnes, Ira C. Davis, Hanor A. Webb, Wilbur L. Beauchamp, John H. Jensen, Clarence M. Pruitt, and W. L. Eikenberry.

# BOOK REVIEWS

BROWN, H. EMMETT, AND SCHWACHTGEN, EDWARD C. *Physics: The Story of Energy.* Boston (285 Columbus Avenue): D. C. Heath and Company, 1954. 596 P. $3.80.

This is the second edition of a most popular and widely used text in high school physics. The subject-matter has been carefully selected and is presented in a most readable style. There is a wealth of illustrations that greatly simplify the understanding of many somewhat abstruse principles and ideas. Each unit has an overview and each chapter is introduced by an interesting discussion. Pupil aids include a chapter summary, lists of things to do, lists of questions, lists of problems, exercises for advanced study, and a list of references. All of these features are an integral phase of the planned learning procedures.

The authors did not hesitate to break away from the usual topical arrangement of most high school texts in physics. The first units in this book are on sound and light and the last unit is on energy and motion. The authors believe this is a much better introduction and more interesting to pupils.

Both authors thoroughly know the subject matter presented, have taught boys and girls physics for many years, and are most familiar with modern theories of education and learning. Dr. Brown was formerly professor of science at the New York State College for Teachers at Buffalo. For the last two years he has been on an educational mission to Formosa. Mr. Schwachtgen is a former science teacher who is now Science Consultant in the Division of Curriculum Development of the Chicago Public Schools.

DAVIS, IRA C., BURNETT, JOHN, AND GROSS, E. WAYNE. *Science: A Story of Observation and Experiment; Books 1 and 2.* New York (383 Madison Avenue): Henry Holt and Company, 1954. 341 P. and 438 P. $3.16 and $3.28, respectively.

The above are the seventh and eighth grade books of a three book series. The earlier editions of these books have been most attractive and well-received by both teachers and pupils. The above two titles are even more attractive in format. Many color plates and attractive photographs and illustrations supplement the well-selected subject matter. In selecting the subject matter the authors have attempted, in general, to meet requirements of various state syllabi and school curricula. Experiments and observations by pupils are stressed.

Each unit begins with a preview *The Story of Observation and Experiment. Questions to Direct the Study of This Unit* precede the textual material for each unit. *Pupil Activities and Demonstrations* are frequently interspersed throughout each unit. There are vocabulary lists, *Questions for Review and Discussion, Tests,* and *Special Reports and Problems.*

Altogether *Science* is one of the most attractive general science series in format appearance, teachability, and well-selected subject matter. Dr. Davis is Professor in the Teaching of Science in the School of Education, University of Wisconsin, and Head of the Science Department, University High School. Mr. Burnett is a teacher of junior high school science and Principal of the Arlington High School, Arlington, Vermont. Mr. Gross is a science teacher in the University High School, Bloomington, Indiana.

CARLETON, ROBERT H., WILLIAMS, HARRY H., AND BUELL, MAHLON H. *Physics for the New Age.* Philadelphia: J. B. Lippincott Company, 1954. 656 P.

*Physics for the New Age,* first published in 1947, has been revised and brought up to date. The textual material, while retaining the used systematic organization, has also integrated with it a "life-situation" approach. This combination seems to appeal both to students and teachers.

The subject-matter is divided into nine units and thirty-eight chapters. The last unit, *Electronics and Nucleonics* is somewhat unique from that found in most textbooks.

It is most timely and well-done. Each unit has an overview and at the end of each chapter is a list of *Questions of Fact and Understanding, Questions for Thought and Application,* and *"A" and "B" Level Problems.* At the end of units are *Honor Credit Problems, Interesting Things To Do,* and *Interesting Things to Read.*

The book is attractive in appearance and format, the subject matter well-selected, the literary style very readable, and the illustrations form an important phase of the teaching and learning process.

CARLETON, ROBERT H., WILLIAMS, HARRY H., BUELL, MAHLON H., AND SCHULER, FREDERICK W. *Physics Activities.* Philadelphia: J. B. Lippincott Company, 1954. 224 P.

*Physics Activities* is designed to accompany the authors' *Physics for the New Age* reviewed above. It can, however, be used with any high school textbook. There are 44 laboratory experiments and 39 learning exercises. Achievement tests for pupil and teacher use are available.

CARLETON, ROBERT H., CARPENTER, FLOYD F., AND WOLINE, R. W. *Chemistry for the New Age.* Philadelphia: J. B. Lippincott Company, 1954. 688 P.

*Chemistry for the New Age* is a revised edition of a high schol text first published in 1949. Two main purposes of high school chemistry are stressed: (1) To contribute generously and effectively to the general education of all of the students, and (2) To help lay the foundations needed by some of the students for later speciali-

zation in science. As a result, the subject-matter and activities included in the text have three major, specific objectives: (1) growth in knowledge and understanding of the more important facts, concepts, and principles of chemistry, (2) growth in the skills and abilities involved in scientific problem-solving, and (3) development of attitudes and appreciations characteristic of the scientific habit of mind.

A most notable feature of the text is the program of learning exercises which should greatly facilitate pupil learning and understanding and possibly simplify the teaching process, if not in ease of teaching, at least in higher standards or goals of accomplishment.

The problem approach is used in the nine units and twenty-two chapters. There are a wealth of practical examples and applications of the fundamentals with numerous educationally worthwhile illustrations.

Each unit is introduced by an overview and interspersed in the reading matter are numerous learning exercises and tests. At the end of chapters is a "Highlights" summary, test exercises, application exercises, and problems.

Carleton, Robert H., Woodburn, John H., and Elder, Jr. Thaddeus H. *Chemistry Activities.* Philadelphia: J. B. Lippincott Company, 1954. 256 P.

*Chemistry Activities* is designed to accompany the authors' *Chemistry for the New Age* reviewed above. There are 48 laboratory exercises and 43 study exercises distributed among the nine units. References are made to other high school textbooks and this book can readily be used with other textbooks. References are also made to other appropriate reading material.

The authors have attempted, and quite successfully, to make this book a truly learning activity for pupils. An *Achievement Test* booklet is available for teacher and class use.

Eisman, Louis and Tanzer, Charles. *Biology and Human Progress.* New York (70 Fifth Avenue): Prentice-Hall, Inc. 1953, 455 P. $4.20.

*Biology and Human Progress* seems to be an exceptionally well done textbook in high school biology. It is written in a most interesting, readable literary style with many thoughtful, challenging student questions and activities. There are an unusually large number of fine illustrations and photographs, adding both to the book's attractiveness and interest. The drawings are by Matthew Kalmenoff, Staff Artist of the American Museum of Natural History.

The ten units are well selected and the book has been read critically by a large number of authorities in the field of biology. There are summary questions and questions for group discussion at the end of each of the many sub-problems. At the end of each unit are suggested laboratory readings and projects. A list of selected readings listed by general topics is found near the close of the book.

Unit tests to accompany the textbooks are available for teachers. Altogether the book seems well organized for ease of teaching and for student interest and understanding. Mr. Eisman is chairman of the department of biology and general science in the Andrew Jackson High School in New York City. Mr. Tanzer is chairman of the science department of the Seward Park High School in New York City.

Schwartz, Julius, Eisman, Louis, and Tanzer, Charles. *Workbook to Accompany Biology and Human Progress.* New York (70 Fifth Avenue): Prentice-Hall, Inc. 1953. 183 P.

This loose-leaf workbook is designed to accompany *Biology and Human Progress* reviewed above. Numerous student activities experiences are provided, many of which are rather unusual. Creative and thought-provoking experiences are emphasized.

Eiseman, Jr., Fred B. *The Why of Chemistry Problems.* St. Louis, Missouri (122 North Seventh Street): Educational Publishers, Inc. 1954. 303 P.

As indicated in the title, this book emphasizes the *why* in solving chemistry problems. The correct answer is important always, but understanding the *why* back of the problem is just as essential if one is to really learn and understand chemistry. Too many students merely memorize in solving chemistry problems and as a result secure a very inadequate and a quick-forgetting of the fundamentals of chemistry.

This book is directed toward the high school student, but college students of beginning chemistry, especially those with no or inadequate high school chemistry backgrounds, will find the book a most useful work.

All types of problems are covered, with lists of typical problems found at the end of chapters, such as the metric system, significant figures, atomic weights, molecular weights, formula writing, gas law problems, equation problems, molality, molarity, equivalent weights, normality, titration problems, and so on.

This is definitely an excellent book for all high school chemistry students—even the teacher!

The author is chairman of the science department at the John Burroughs School of Clayton, Missouri.

Smith, Victor C. and Vance, B. B. *Science for Everyday Use.* Philadelphia: J. B. Lippincott Company, 1954. 737 P.

This is the third edition of a one-year eighth or ninth grade general science textbook first published in 1946. Much material has been revised or rewritten and new material added.

The text is organized into six units and eight-

een chapters. Pupil activities such as self-tests, individual and class experiments, teacher demonstrations, and visual aids are woven into the subject-matter of each chapter. At the end of chapters are found word lists, review questions, lists of related ideas, thought questions, and interesting books to read. No workbook is needed to supplement this text—only a pupil note-book. A wealth of photographs, graphs, and charts supplement the textual material.

VANCE, B. B. AND MILLER, D. F. *Biology for You.* Philadelphia: J. B. Lippincott Company, 1954. 652 P.

*Biology for You* is the third edition of a high school biology textbook first published in 1946.

Previous editions of the text have been quite popular both with teachers and pupils. Written in a most readable literary style, well illustrated, and interesting content combine to make a fine high school biology text.

The subject-matter is divided into fifteen units. Each unit has an overview with suggested readings and review questions interspersed with the textual material. At the close of each unit is a summary, questions on the unit, problems in scientific thinking, things to do, and lists of supplementary reading material.

VANCE, B. B., BARKER, C. A., AND MILLER, D. F. *Biology Activities.* Philadelphia: J. B. Lippincott Company, 1954. 256 P.

*Biology Activities* is designed to accompany the authors' *Biology For You* reviewed above. Sixty laboratory activities are included. There are also optional activities, study questions, additional, and assignment suggestions. At the end of the manual is a list of suggested student and class projects—slightly less than a hundred in all. Achievement tests for pupils and teachers are available.

WEAVER, ELBERT C. AND FOSTER, LAWRENCE S. *Chemistry for Our Times.* New York (330 West 42nd Street): McGraw-Hill Book Company, Inc. 1954. 666 P. $4.12.

This is the second edition of a high school text in chemistry, first published in 1947. The textual material has been brought up-to-date and some parts revised. The book covers the field of high school chemistry in a most adequate manner and all students using the text should obtain a thorough background in the fundamentals of chemistry. Seemingly the text would serve most adequately the college-bound and the chemistry-bound student without neglecting the many high school chemistry students for which this is the terminal chemistry course.

The text is well-written and well-illustrated. The writers have stuck to the fundamentals both as to subject matter and pupil aids. No attempt has been made to make these especially "interest-catching." There is a list of text-films to accompany the text available from the publishers.

BROWNLEE, RAYMOND B., FULLER, ROBERT W., WHITSIT, JESSE E. HANCOCK, WILLIAM J., AND SOHON, MICHAEL. *Elements of Chemistry. Teachers' Manual for Elements of Chemistry.* Boston (50 Beacon Street): Allyn and Bacon, 1954. 708 P. 228 P.

Through the years *Elements of Chemistry* has been a most popular book both with pupils and teachers. In the several editions, the text has been probably the most widely used high school text ever published. Rapidly changing ideas in certain aspects of chemistry have been incorporated into this new edition. Newer concepts of teaching and psychology have been utilized in this revised edition.

Scientific thinking has been emphasized. Nearly 400 diagrams and photographs add to the interest and a better understanding of the textual material. There are 9 color plates.

The 35 chapters cover the usual subject-matter of high school chemistry. The textual material should give pre-college students and pre-college chemistry students a thorough preparation in the fundamentals of chemistry. Terminal high school students will find the content interesting and within their comprehension. Many student teacher aids are included.

*The Teachers' Manual* provides most helpful information to the questions asked in the text.

BAKER, D. LEE, BROWNLEE, RAYMOND B., AND FULLER, ROBERT W. *Elements of Physics; Teacher's Manual of Elements of Physics.* Boston (50 Beacon Street): Allyn and Bacon, 1953. 677 P.; 212 P.

This new edition of *Elements of Physics* brings up-to-date a text that has long been unusually popular with high school teachers and pupils. The format has been made most attractive. The general appearance, teachability, organization, and pupil appeal have been greatly improved over the first edition. The connection between physics and modern life is always kept in mind.

Especial attention has been paid to vocabulary and general readability. Full-color kodachromes are scattered throughout. The photographs and illustrations are clear and pertinent to the subject-matter under discussion.

Undoubtedly this new *Elements of Physics* will continue the wide-usage and popularity of the earlier editions.

The *Teacher's Manual of Elements of Physics* provides answers to the question found at the end of the various chapters. It is available to teachers using the text.

BURNS, ELMER E., VERWIEBE, FRANK L., HAZEL, HERBERT C., AND VAN HOOFT, GORDON E. *Physics: A Basic Science.* New York (250 Fourth Avenue): D. Van Nostrand Company, Inc. 1954. 546 P. $4.12.

The over-all organization of the earlier editions has been modified in this third edition. A unit on *Molecular Physics* introduces the text and a

unit on *Electronics and Nuclear Physics* completes the ten units. The usual areas in high school physics are found in between the above two units.

Teaching aids include a brief and challenging introduction at the beginning of each unit, summary questions, general questions, student projects, A and B lists of figures, and tables of physical constants.

The text *Physics: A Basic Course* truly lives up to its name and will give all students using it a basic course in the fundamentals of physics. It stresses the interrelationships of the various principles of physics.

SMITH, ELLA THEA. *Exploring Biology.* New York: Harcourt, Brace and Company, 1954. 579 P. $4.12.

This fourth edition of a widely used text in high school biology has been thoroughly revised and brought up to date. A new 18-page pictorial introduction provides a dramatic introduction and overview of the book and the course. Many of the ten units have been revised, rewritten, and in some instances greatly expanded. New typography, many new half-tones and drawings make for a very attractive text. Color is used throughout as a teaching signal—red for animal and human physiology, green for plant structures containing chlorophyll, violet for the nervous systems, and brown for habitat. New thought problems have been added at the end of each chapter. Student aids include such additional features as Your Biology Word List, Your Conclusion, List of Readings, Suggested Activities, and Overviews.

Altogether this is a most attractive text that has proved its teachabilty and student appeal in the previous editions and promises to continue to do so with this improved edition.

DULL, CHARLES E., BROOKS, WILLIAM O., AND METCALFE, H. CLARK. *Modern Chemistry.* New York (383 Madison Avenue). Henry Holt and Company, 1954. 587 P. $3.88.

*Modern Chemistry* is a completely rewritten and revised edition of a high school chemistry text first written by the late Mr. Dull many years ago. The various editions have had wide appeal to both pupils and teachers. This text should continue that wide usage for it is undoubtedly the best written and most attractive in format of all of the editions. Obsolete materials, processes, and theories have been eliminated in bringing the textual material completely up to date. Many teaching aids have been included. Especial attention has been paid to vocabulary, summary statements, questions, problems, and student projects and activities. A knowledge of the principles and subject matter of this text will assure the pupil a thorough background in pre-college chemistry. Non-science majors will find the material most interestingly written and not beyond their comprehension or understanding.

BUTLER, CHARLES H. *Arithmetic for High Schools.* Boston: D. C. Heath and Company, 1953. 336 P. $2.40.

Most science teachers would affirm that there is a real need for a course in arithmetic in high school. There has been a demand, an ever-increasing demand, for more emphasis on arithmetic. Slowly, educators are being convinced that high school students, whether graduating or not, need a more functioned knowledge of mathematics whether they go into business, into industry, the military forces, to college, or become homemakers.

This book would seem to be a fine textbook for a most desirable high school course. Students obtaining a good degree of mastery of this text will have an adequate knowledge of arithmetic. It would serve as an excellent text for a review of important fundamentals. Elementary teachers could use it as a good "brush-up."

SLADE, SAMUEL AND MARGOLIS, LOUIS. *Mathematics for Technical and Vocational Schools.* New York (440 Fourth Avenue): John Wiley and Sons, Inc., 1955. 574 P. $4.48.

This is the fourth edition of a high school textbook in mathematics first published in 1922. The emphasis is on practical mathematics as applied to technical and trade work.

Symposium. *Your Career in Teaching; Your Opportunities in Science and Engineering; Your Future Is What You Make It; Your Opportunity in Management; Working Together; Pioneers of Progress; Our Land, Our Spirit; Patents and Your Tomorrow; Production; Key to Progress Dollars in Shirt Sleeves; May the Best Man Win;* and *Your Money Is What You Make It.* New York (14 West 49th Street). National Association of Manufacturers, 1953. 16 P; 30 P; 30 P; 31 P; 44 P; 38 P; 16 P; 22 P; 10 P; 10 P; 10 P; 10 P. Each Pamphlet free.

The above series of pamphlets discuss a variety of topics: teaching, science, engineering, business-and management, and other vocations as careers; work-study training courses for youth; the study of progress through the ages; conservation; the importance of patents; the story of production; the story of profits; the story of competitive enterprise; and the value of money.

The above pamphlets are especially intended for high school teachers and pupils. Guidance teachers, science teachers, and social studies teachers will especially find the pamphlets valuable.

LANSDOWN, BRENDA. *The Electro-Magnetic Background of the Atom.* Brooklyn: Brenda Lansdown, Brooklyn College, 1951. 94 P.

This is the No. 2 *Workbook of Scientific Thinking,* the third of which *The Electronic Back-*

*ground of the Atom* will be published soon. This workbook is a pupil loose-leaf notebook type. Historical reading material is interspersed with questions for students and suggested experiments. The reading material begins with the origins of study of magnetism and ends with the work of Mendeleef and the Periodic Table.

The overall purpose of this workbook for secondary students is to develop in students scientific habits of thinking and working. The approach is an historical one in which the author uses many interesting incidents and descriptions of experiments, used originally by the scientist himself.

STERNAU, PHYLLIS. *Sweet Sixteen Cook Book.* New York (215 East 37th Street): Sterling Publishing Company. 124 P. $2.00.

This book is for the beginner and aims to bridge the gap between childish cooking games and adult kitchen behavior. The author says all cooks, even the greatest chefs, were beginners once. All have made mistakes. This book is intended to help reduce the number of those mistakes. Many helpful hints are given. About every aspect of cooking and meal planning is covered—from picnics, snacks, slumber parties, pot luck suppers, ordinary meals, to guests and holiday treats. Salads, meats, vegetables, fruits, desserts, beverages, pies, cakes, cookies, soups, special dishes, and so on, are included.

Any one who can read and follow directions can cook. Here is a fine book for beginners!

ANONYMOUS. *Poliomyelitis: A Source Book for High School Students; Poliomyelitis: A High School Teacher's Guide.* New York (120 Broadway): The National Foundation for Infantile Paralysis. 1954. 24 P. each. Free.

The above two pamphlets comprise a unit on poliomyelitis. The material is suitable for science and health classes. There are objectives, student content, teacher background material, suggested classroom activities, charts, suggested films, and so on.

GARST, SHANNON. *Will Rogers: Immortal Cowboy.* New York: Julian Messner, Inc. 1952. 174 P. $2.75.

Will Rogers is rapidly becoming a legend and one of America's immortals. Will Rogers was unique—as characteristically American as Abe Lincoln. When Will Rogers died in a plane crash in Alaska in August 1935, America lost one of its all-time great characters and one destined never to be replaced. He was truly one of America's greatest humorists.

Seemingly few boys ever gave less portent of future world renown or ever detested school more. Will Rogers was born at Oologah near Claremore, in Indian Territory in 1879. He was always proud of his one-eighth Cherokee blood. He felt very keenly the death of his mother Mary when he was ten years old. At his father Clem's insistent demand, he attended a number of schools, miserably failing in each. He always had the wanderlust for traveling. In his youth his major interest was rope twirling and to a less degree, cattle ranching. His wanderings took him to Texas, Colorado, California, New York, England, the Argentine, South Africa in his early youth, and this trait really lasted all of his life. Will finally found his real interest in life in a circus in South Africa. Always shy, after a brief, sporadic courtship he married Betty Blake. He gained world renown for his rope twirling and acting on Broadway, his movies, and his widely syndicated newspaper sayings.

Probably his two most widely quoted sayings were "I never met a man I didn't like" and "All I know is what I read in the papers."

Will Rogers had a most interesting life and it is well told in this biography by Shannon Garst.

KUGELMASS, J. ALVIN. *J. Robert Oppenheimer and the Atomic Story.* New York (8 West 40th Street): Julian Messner, Inc. 1953. 179 P. $2.75.

J. Robert Oppenheimer will always be remembered as the man who built the atomic bomb. His technical genius enabled the United States to make complete utilization of its scientific "know-how" in atomic research. This practical side may have been even more important than the purely scientific accomplishments.

J. Robert Oppenheimer was born in New York City, April 22, 1904. At a very early age he gave evidence of being very gifted intellectually —a genius or a prodigy in fact. He showed an amazing grasp of languages (he now speaks or can read 8) especially Latin, Greek, and the Romance languages. His hobby was science. He attended and graduated from the Ethical Culture School in New York City and completed his degree work at Harvard University in three years, graduating summa cum laude at the age of twenty. Then he studied at Cambridge and the University of Gotteingen where he obtained his Ph.D. degree. His undergraduate major was chemistry but he switched to theoretical physics for his graduate work. He showed no unusual genius at laboratory or experimental research but was truly a genius in the theoretical aspects of physical science.

A brief breakdown in health caused him to live briefly on a New Mexico ranch. Subsequently he became professor of physics at the University of California at Los Angeles and the California Institute of Technology. At the age of 39 he was called to take charge of the Los Alamos Scientific Laboratory—directing 4500 workers who were working on the making of the A-bomb. Presently he is Director of the Institute for Advanced Study in Princeton, New Jersey.

Interspersed with this most interesting biographical sketch is much information about the research in atomic energy and its practical peacetime uses. Mr. Kugelmass will be remembered

for his earlier *Louis Braille* and *Ralph J. Bunche*. This book will make an excellent addition to the secondary science book shelf.

MACDONALD, ZILLAH K. *A Cap for Corrine*. New York: Julian Messner, Inc. 1953. 184 P. $2.50.

Although fictional, this story of nurse training, would serve most appropriately for a supplementary book on careers. Corinne is one of a large class of graduating nurses at St. Agatha's Hospital. Her parents wish her to marry a wealthy Captain Heathby Grant upon graduation. Corrinne realizes that would run counter to her ideals of service. A romantic interest is supplied by a young Doctor John Morton Burnette, a pathologist, experimenting upon himself with tropical fever drugs. Then there is the gallant Lady Kitty, Petry the crippled boy, and the other graduating nurses Claire, Barbara Ann, and others. Woven into the story is much of the life of nursing, hospital and private, and the hospital work of doctors.

LONGSTRETH, T. MORRIS. *Time Flight*. New York (60 Fifth Avenue): The Macmillan Company, 1954. 216 P. $2.75.

*Time Flight* is the story of two boys—Rich McClain from a ranch in Wyoming who goes to visit his cousin Doug Kerman in Pennsylvania. Doug is cramming for a history examination and Rich becomes interested in a book in which the characters are transported back into past "Alley-Oop" like. Doug and Rich find themselves suddenly transported from 1953 to 1692. They find themselves in the midst of the Salem witchcraft trials and activities. That Doug and Rich find themselves in hot water immediately is putting it mildly. They learn about early American customs, witchcraft, meet Cotton Mather, Judge Stoughton, Joseph Putnam, Penitence, Mercy, and Misery. This is an unusual way to present events of the past and should be most interesting to many boys and girls.

JAEGER, ELLSWORTH. *Land and Water Trails*. New York: The Macmillan Company, 1953. 227 P. $2.95.

The contents of this book are divided into seven parts. The author in the first part considers water travel in some detail—means, procedures, safeguards. Part two considers animal transportation including saddles. Knots and lashings are considered in the next 24 pages. Then follows a chapter on annoying and dangerous pests with some suggested insecticides and repellants. Wilderness critters occupies some 80 pages. Many kinds are considered here. Critter signs include numerous signs through which animals may be detected. The last chapter is tomorrow's wilderness—a plea for conservation.

Scout leaders, scouts, and other outdoor enthusiasts will find the first 80 pages interesting and useful. The rest of the book will appeal to science students as well as the former groups which are by no means sharply differentiated. There are 108 plates of drawings by the author to supplement the textual material. These drawings do add greatly to the interest and worthwhileness of the textual material.

Mr. Jaeger is Curator of Education, Hayes Professor of Science, Buffalo Museum of Science. He is an unusually good writer on outdoor life as many readers of his other writings will attest. These writings include: *Wildwood Wisdom, Tracks and Trailcraft, Nature Crafts, Council Fires, Easy Crafts,* and *Woodsmoke*. This book is recommended as an excellent addition to the science library—elementary or secondary.

LATHAM, JEAN LEE. *The Story of Eli Whitney*. New York (55 Fifth Avenue): Aladdin Books, 1953. 192 P. $1.75.

*The Story of Eli Whitney* is one of the *American Heritage* series. This is a valuable contribution on the life of a very important American for not too much has been written about Eli Whitney. Based upon historical research and attempting to make it as authentic as possible, naturally much of the conversation is fictional.

The author has written a dramatic story of a great American, his struggles and final triumph. Disinterested in farming, Eli Whitney graduated from Yale University at the age of twenty six and planned to become a lawyer while tutoring in Georgia. On the way to Georgia by boat, tall Eli Whitney met Mrs. Catherine Greene, widow of the American Revolutionary War General Nathaniel Greene. The tutoring salary turning out to be disappointingly small, young Eli Whitney became a guest of Mrs. Greene at her Mulberry Grove rice plantation. She persuades young Eli to turn his natural mechanical ability to devise a machine for removing cotton lint from the seed. By hand a man could free a pound of cotton from the seed in about a day. Reluctant at first, Whitney became enthusiastic in working on the new cotton gin on the Mulberry Grove Plantation. His financial partner and friend Phineas Miller later married Mrs. Greene. Yellow fever, delays in patent rights, pirating of models caused much disappointment regarding the development of the cotton gin. Lawsuits, finally won, came so near the end of the patent right period, that actually Eli Whitney realized nothing from that great invention.

In many ways equally important was Eli Whitney's invention of interchangeable parts in machinery—a musket which revolutionized the arms industry. Here his genius was as evident as in his work on the cotton gin. Similar disappointment dogged his steps here but again he proved his ideas were both practical and revolutionary.

This is a fine book for all teen-age Americans. The literary style makes for easy and interesting reading.

NATHAN, ADELE GUTMAN. *Wheat Wont Wait.* New York (55 Fifth Avenue): Aladdin Books, 1952. 192 P. $1.75.

*Wheat Wont Wait* is one of the Aladdin *American Heritage Series* of dramatic stories of men and women who helped make America what it has become. The series brings to life outstanding events, places, and personalities. The books should inspire young people to a better understanding and appreciation of what America really is. Maybe if the twenty-two American soldiers in Korea who recently refused to return to America had read this series, some or even all of them would have made a different decision. Something unfortunate happened in their lives—their parents, teachers in general, history teachers, army superiors somewhere failed—one or maybe all.

In this story, the author tells about the life of Cyrus McCormick and his invention of the wheat binder. This machine has been as important or maybe even more important than Whitney's cotton gin. It revolutionized wheat cultivation. The idea started first with Cyric Robert McCormick, father of Cyrus. But at this age of 22 young Cyrus in his father's forge at Walnut Grove in Rockbridge County, Virginia, made the first crude wheat reaper—the year 1831. As usual, many discouragements came before the first reaper was invented and almost even more after the initial success. The first real success came with the opening of a reaper factory in Chicago and the development of the mid-west wheat section.

This is a most interesting story about the life of one of the world's most important inventors. It is an excellent book for all young Americans to read and is recommended for the high school library.

LAFARGE, OLIVER. *Cochise of Arizona.* New York (55 Fifth Avenue): Aladdin Books, 1953. 191 P. $1.75.

Only the conversation phases of this story are fictional. All of the major incidents are factual and the characters are real persons. The author tells the story of one of the greatest of all American Indian chiefs, Cochise of the Chiricahua Apaches of Arizona. The story is told from the Indian viewpoint which is quite different from the usual white man accounts.

Cochise was for peace and his word once given was never broken. No white man ever had a higher code of honor in this respect. Wrongly accused of stealing a half-Indian boy, war between the Chiricahuas and the whites broke out in 1861. Cochise tried in vain to avert the war but a stupid, arrogant Lt. Bascom of the American military forces determined to wipe out the whole Chiricahua tribe consisting of slightly more than 200 fighting men. No Indian tribe ever had a more resourceful leader so the war dragged on for over ten years. Jefford, a white man, became Cochise's close and trusted friend. He arranged a meeting between Major General Howard recently arrived from Washington, and a Bible-reading soldier, and Cochise the religious-minded warrior. They found they could trust each other and peace immediately resulted. Later the white men broke their solemn treaty and war broke out again.

*Cochise of Arizona,* one of Aladdin's *American Heritage Series,* is a fascinating true story of early American history that should hold the interest of most teen-agers.

STERNE, EMMA GELDERS. *The Long Black Schooner.* New York (55 Fifth Avenue): Aladdin Books, 1953. 192 P. $1.75.

This is another title in the Aladdin *American Heritage Series.* The story is based upon authentic incidents of the epic voyage of the schooner *Amistad* and her boatload of Negro captives—an incident that actually reached the U. S. Supreme Court after being fought all the way up through the lower courts.

The story is dramatically told from the viewpoint of the Negroes themselves. Unlawfully seized in the Mandi Country of Africa, the Negroes were sold illegally under Spanish rule into slavery for a sugar plantation in western Cuba. On the way from Havana to the plantation the Negroes loose their irons, kill Captain Ferrer of the boat, and seize control. Other crew members are allowed to escape but the slave owner Ruiz and Montez, another Spaniard, are held prisoners. Under the leadership of Cinque and Tua, the Negroes decide to sail the vessel back to Africa. Knowing practically nothing of sailing a sail vessel, about all they knew was to sail east which they could do in the daytime. At night under unknown stars they were completely lost. The Negroes bargained with Ruiz and Montez to sail the ship at night. Betraying their agreement Ruiz and Montez head the ship North at night. Thus the ship never reaches Africa but zig-zags along the American coast. Finally the ship is seized off Long Island and then begins the long legal battle as to whether the Negroes are actually runaway slaves that have mutinied as Ruiz and Montez claim or were they really free men illegally seized. One of the difficulties in presenting the Negro side was to find some one who could understand the Mandi language. A sailor, who had been a Mandi, was finally found, resolving this difficulty. Then began the long series of trials which to the everlasting honor and glory of the United States was resolved in every case in favor of the Negroes and which finally reached the U. S. Supreme Court where the case was successfully argued by ex-president John Quincy Adams.

This is an interesting, well written story for all American teen-agers.

Boynick, David K. *Champions By Setback.* New York: Thomas Y. Crowell Company, 1954. 205 P. $2.75.

*Champions By Setback* tells about famous athletes who overcame serious physical handicaps of earlier years. The examples of these persons could be duplicated in all lines of human endeavor—science, music, art, ministry, medicine, law, engineering, business, and so on. These persons all had a comomn characteristic—call it "heart," "spirit," "determination," "will to win," and so on. Seemingly by a miracle, they have each performed outstandingly to surpass others seemingly less in ability and without observable handicaps.

This is a fine story for all physically handicapped persons and others as well. Boys interested in sports will especially like the story. Examples from each of the major sports have been selected—Glenn Cunningham, Bill Bonthron, and Sam Romani, the great milers; James J. Braddock, the world heavy-weight boxing champion; Ted Norris, the great swimmer; Georgie ("The Iceman") Woolf, the jockey; Jack ("the Mighty Mouse") Hackett, football star of the University of Miami; Ham Richardson, the Golden Boy in tennis; Charles A. Boswell, football and baseball star who became a champion golfer, although blind; and Martin Marion, one of the greatest shortstops in baseball and presently manager of the Chicago White Sox.

Harkins, Philip. *Road Race.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1954. 276 P. $2.50.

The main emphasis of *Road Race* is on *driver education* and *safety education.* Teen-age boys will enjoy this story because, to so many of them driving a car—especially a car of their own—represents the very essence of their ambitions and lives. Max Werner, president of the mill-town Hot Rod Club, represents the reckless driver who deliberately flouts not only legal laws but safety measures. David Neal excellent mechanic, flouts the law to make the Hot Rod Club and is arrested. Webb Walden takes Dave as one of his mechanics and helps him to win a legal, authorized road race in a sport model car. This is a fine book to teach young boys the need, advantages, and thrills that may be had by obeying traffic laws and safety precautions.

Shoemaker, Robert H. *Famous Football Players.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1953. 214 P. $2.75.

Exploits of some of the greatest football players of all time are described including both their college and professional playing. The players whose feats are described are: Sammy Baugh, Tom Harmon, Red Grange, Jim Thorpe, Otto Graham, Dick Kazmaier, the Four Horsemen, Bob Waterfield, Doc Blanchard, Glenn Davis, Mel Hein, Don Hutson, Elroy Hirsch, Doak Walker, Walter Camp, and Albie Booth.

Parker, Elinor. *Most Gracious Majesty: The Story of Queen Elizabeth II.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1954. 181 P. $2.75.

Queen Elizabeth II and Philip recently completed their six months tour around the world. Everywhere multitudes of gracious subjects greeted them warmly and enthusiastically. Not only were the people paying homage to their Queen but also to a very fine person in her own right. Probably England has never had a ruler so well-beloved by so great a majority of the sovereign subjects. Nor have they had one who seems to have been better qualified for the position to be filled.

In this well told story, the day-by-day life of Queen Elizabeth II unfolds. Against a rich background of pride and tradition, Princess Elizabeth from the day of her birth to her Coronation as Queen Elizabeth II, lived a life of more or less preparation for the one great day. In between were days of joy, sorrow, hard work, education, love, motherhood.

The author who witnessed the Coronation of the Queen as well as that of her father, George V, writes understandingly and sympathetically. A number of photographs showing events in the life of the Queen are included. This is a well-told biography of the world's best known woman, suitable reading for both teen-agers and adults.

Hertz, Louis H. *Making Your Model Railroad.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1954. 216 P. $2.75.

This book explains in simple terms the workings of all types of real and model railroad locomotives and accessories. There are dozens of specially prepared drawings. This is a fine book for boys, and men, too, interested in building railroad models as a hobby or major leisure-time activities. Every little detail of building and setting up models is included.

Frank, R. Jr. *Work Boats.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1954. 146 P. $2.50.

Fifteen varieties of work boats operating on both coasts and from the Great Lakes to the Gulf of Mexico are described. There are harbor tugboats, dredges, menhaden fishing boats, sponge fishing boats, towboats, river and canal barges, harbor barges, lightships, fire boats, salmon fishing boats, iron ore and wheat freighters of the Great Lakes, harbor sweepers, floating cranes, and ferry boats.

The story is simply told in factual stories and

detailed illustrations. The textual material is suitable for junior high school pupils and teenagers. It is a good reference on many types of coastal boats.

COOMBS, CHARLES. *Skyrocketing Into the Unknown.* New York (425 Fourth Avenue): William Morrow and Company, 1954. 256 P. $4.00.

This is a survey of the entire field of jet and rocket flight. First we see through a test pilot's own eyes how he meets and escapes a flyer's worst enemy—fire. Then follows a typical experimental flight in a rocket-powered research airplane. A detailed account of the latest types of rocket and jet planes is given, together with the equipment devised to protect the life of a high-altitude pilot. The operating principles of rocket and jet planes are given and an explanation of why rockets are capable of space travel, although jet engines are not. The penetration of the sonic barrier was one of the most dramatic air-research achievements in recent years. The experiment proved that there is no such thing as a solid sonic wall capable of tearing a well-constructed airplane apart.

There are 141 unusually fine photographs—a collection which alone would make this an outstanding book—of great value for many years to come.

It is an excellent book for lay readers and for the high school science book shelf. Boys, especially those having an interest and curiosity about flying, will be thrilled by this book. A library having this book can be assured of its continuous circulation.

GAMOW, GEORGE. *Mr. Tompkins Learns the Facts of Life.* New York (32 East 57th Street): Cambridge University Press, 1954. 88 P. $2.75.

A number of readers will recall with pleasure, the author's earlier *Mr. Tompkins In Wonderland* and *Mr. Tompkins Explores the Atom.* In this book Mr. Tompkins turns to the field of human biology for his adventures. First he is injected into himself and travels extensively in his own bloodstream and discovers the functions of his cells and bloodstream. Following this adventure he meets a motherly gene and learns all about his own heredity. A third adventure involves a journey within his own brain where he learns about the composition and broad principles of the brain and nervous system. Finally he hears a lecture on the topic of what is life?; how did it start?; how do certain forms of energy (atoms) combine into complex molecules becoming living cells?

Readers will enjoy this new Mr. Tompkins adventure and learn many interesting facts and principles about human biology.

LAMOND, HENRY G. *Kangaroo.* New York: The John Day Company, 1953. 247 P. $3.50.

*Kangaroo* is the story of a kangaroo of the bush country of Australia. It is the story of the life of Big Red whose father was also known as Big Red. The author describes the life of Big Red from the moment of his birth until he attains a herd of does of his own. Probably this is the most accurate, realistic account of the life of a kangaroo that is available in book form.

For this reason the book should be of especial interest to American readers. Interest in stories of kangaroos has always been high among American readers, whose direct knowledge of kangaroos has been limited to zoos and cartoons.

In this story the life of kangaroos in their native environment is realistically portrayed. Big Red battles against floods, drought, natural enemies such as dingoes and also especially man, and other kangaroos. The story is laid in the native bush country of Australia, a region familiar to the author. Mr. Lamond is a well-known Australian nature-writer. He is the author of *Dingo, Brindle, Royalist,* and *Kilgour's Mare.*

Junior High School students will find this a most interesting book and a source of accurate information. Elementary science teachers will find it an excellent resource book. It is recommended for the science library.

LEYSON, CAPTAIN BURR W. *Man, Rockets, and Space.* New York (300 Fourth Avenue): E. P. Dutton and Company, 1954. 188 P. $3.50.

This is a clear, factual account of the latest developments and experiments by the U. S. Government on rockets, space travel, and the possibilities of inter-planetary communication. All facts presented have been thoroughly documented and the plans for the conquest of space are those of Dr. Wernher von Braun, Technical Director of the Red Stone Arsenal at Huntsville, Alabama, and one of the originators of Germany's V-2 rockets. There are a number of photographs of the latest government developments—some recently released for the first time from the security list.

There are reports of the Skybooks which carry instruments into the high altitudes to give us all of the data for rocket ships; here, too, is the wonderful story of the WAC Corporal Rocket which rode pickaback on a V-2 and continued to a height of 240 miles. Here is the Viking, 48 feet long, which costs $200,000. There is also details of Dr. von Braun's plan for establishing an orbiting station in space, like a great doughnut, which Braun believes can be assembled in space some 1075 miles from the earth to dominate the world.

Cosmic rays scarcely mentioned in most space-travel discussions, will probably be one of the very greatest obstacles to space travel. Captain Leyson discusses the possibilities of life on each of the planets and on the moon. Probably the

moon and much more remotely Mars offer the only slight possibility of space travel to bodies in space.

*Man, Rockets, and Space* would make an unusually fine addition to the high school science library and to the science teacher's own personal library.

Gatland, Kenneth W. and Kunesch, Anthony M. *Space Travel.* New York: Philosophical Library, 1953. 205 P. $4.75.

Man seems to be increasingly interested in space travel and communication. *Space Travel* is an illustrated survey of the problems and prospects of space travel. The authors briefly describe the whole history of rocket development from the first days of first discovery of explosives before the birth of Christ down to the present jet developments. Earlier developments of jet propulsion and rockets took place in Germany before and during World War II. Developments since then have been very rapid, especially in America, to a lesser extent in England, and to an unknown degree in Russia.

The book goes into some detail in the theory and practical developments of rockets, the possibilities of space travel to the moon, Mars, Venus, the other planets, and bodies outside of the solar system. Many of the practical problems involved are discussed. The author goes into some detail regarding the problem of building a space platform that would continuously encircle the earth, and discusses the possible uses of such a platform. Many photographs and diagrams enhance the reading material. *Space Travel* is both a historical and practical account of the development and possible developments in rocket flight.

Poole, Lynn. *Your Trip Into Space.* New York: Whittlesey House, McGraw-Hill Book Company, Inc. 1953. 224 P. $2.75.

This book almost convinces one that space travel is just around the corner in the not too distant future. Many scientists believe a trip to the moon will be made in less than fifty years. This is a popular account suitable for laymen and high school teen-agers, based on much research and numerous authorities in the field. The author is the widely known producer of the Johns Hopkins TV Science Review and author of *Today's Science and You* and *Science via Television.* The information in this book is both fascinating and thoroughly checked for accuracy.

The many problems and difficulties to be worked out and overcome are described in this book: ultra-violet rays, cosmic rays, meteors, heat, speed, food, pressure, fuel, acceleration, gravity, and so on.

Many dangers exist in space travel but the author believes that they can be overcome. It will be necessary first to build a space satellite or platform some 1,000 miles or so above the earth. This feat is not fantastic or impossible. The moon rocket will be launched from this space satellite. The space satellite can be used for many other purposes, too, such as earth weather observation, astronomical observations, and so on. Communication with the earth and other members of the space crew will be by means of radio.

Problems of getting to the space satellite orbit, building the satellite, and launching the moon ship are discussed in some detail. There are many illustrations by Clifford Geary. Space flight is about as simply and at the same time accurately described in this book as one is likely to read. It is a highly recommended book for the secondary science book shelf.

Sloane, William (Editor). *Space Space Space.* New York (699 Madison Avenue): Franklin Watts, Inc. 1953. 288 P. $2.50.

Space travel possibilities have been receiving much attention by both adults and youths, scientists and laymen, within recent years. Possibility of space travel to the moon, or Mars, or Venus, or even more remote planets is being considered even by serious minded scientists and not merely by imaginative boys and science-fiction writers. Such space flights are now in a highly speculative realm and even a suggestive future date for such a flight is most highly speculative.

These considerations have not lessened the demand of a certain part of the reading public, especially many boys but also quite a few adults for science fiction reading. Writers have tried to meet this demand both through science fiction books and science fiction articles in magazines. Because science fiction is just about the most imaginative story telling in the modern world, it has attracted a group of exceptionally fine writers. One of these writers is the editor of this book *Space Space Space* which is a collection of space stories by other writers. Mr. Sloane is Editorial Vice President of Funk and Wagnalls, a New York Publishing House and author of two science fiction books *To Walk the Night* and *The Edge of Running Water.*

There are ten selected science fiction stories in *Space Space Space.* They were selected from stories appearing in various science fiction magazines. The stories will be most interesting to any readers who get enjoyment in science fiction. The stories differ quite widely but all of them have the element of suspense and possibility that seems to thrill science fiction enthusiasts.

Norton, Andre. *Star Man's Son: 2250 A. D.* New York: Harcourt, Brace and Company, 1953. 248 P. $2.75.

This is a science-fiction adventure story whose characters live in 2250 A. D. Generations previously most of mankind had been wiped out in a global atomic war. Now only remnants of human kind and decaying and deserted cities, war machine relics, and so on served as evidence of

a once great civilization. In a vast, hostile wilderness there were all sorts of strange creatures such as strange rats, strange cats and misshapen creatures, once human, whom radiations had changed into feared subhuman Beast Things.

In this environment Fors, a white mutant, of the Puma Clan of the Mountains had dreamed of becoming a leader—a Star Man like his late father. Because he was a mutant and thus set aside as a man to be avoided, Fors is denied membership in the Star Men who seek out old cities for forgotten knowledge of the past. Fors then leaves his mountain home accompanied by his large hunting cat Lura and sets out to find a large deserted city his father believed existed far away. After encounters with Plainsmen, Fors does reach the unknown deserted city. Here he rescues Arskane a man from another tribe of the South. They are captured by the Beast Things but in the end Fors and Arskane help to defeat the Beast Things in a great battle and thus enable the various tribes to start on an avowed road toward universal peace. Altogether this a thrilling story of high adventure that should hold the attention of the most avid science fiction adventure fan.

ALCORN, MARVIN D., HOUSEMAN, RICHARD A., AND SCHUNERT, JIM R. *Better Teaching in Secondary Schools.* New York (383 Madison Avenue): Henry Holt and Company, 1954. 525 P. $4.25.

*Better Teaching in Secondary Schools* is designed to help the classroom teacher. It is based on what a teacher does, beginning with the first day in the classroom and ending with steps to professional growth and advancement. The material is based on experiment, observation, and reflection on the part of the authors. The authors have been teachers and administrators in secondary schools and teachers of student teachers at the college level. Presently they are professors at San Diego State College.

The text should have a real appeal to student teachers for several reasons: literary style and readability, accent on the practical, and content discussed. Teachers of experience will find the book interesting to read, with good probability of meeting some real needs.

SYMPOSIUM. *Modern Learning Theory.* New York (35 W. 32nd Street): Appleton-Century-Crofts, 1954. 379 P. $5.00.

This book presents a critical analysis of five learning theories. Under grants from the Carnegie Corporation, a group of seven young psychologists conducted a seminar at Dartmouth University. The psychologists were: William K. Estes, Indiana University; Sigmund Koch, Duke University; Kenneth MacCorquodale, University of Minnesota; Paul E. Meehl, University of Minnesota; Conrad G. Mueller, Jr., Columbia University; William N. Schoenfeld, Columbia University; and William S. Verplands, Harvard University.

The learning theories of Clark L. Hull, Edward C. Tolman, Burrhus F. Skinner, Kurt Lewin, and Edwin R. Guthrie were considered. This book presents a critical analysis of each theory based upon conference and seminar work involving all members of the group, but each theory presented by one or two writers.

RUSK, ROGERS D. *Introduction to College Physics.* New York (35 West 32nd Street): Appleton-Century-Crofts, Inc., 1954. 816 P. $6.50.

This book is designed to be of interest to first year college students and also those who wish to go further in physics and other sciences. Mathematical preparation beyond high school is not necessary and the use of more advanced mathematics is developed in the text itself.

The author believes that a course in college physics should develop some appreciation of the historical development of physics, the methods by which science develops and achieves its ends, together with something of its broader relations and creative spirit. There are numerous illustrative examples and problems.

The book seems very well written and should appeal to the student desiring to learn the fundamentals of physics and an appreciation of its contributions to man's welfare and thinking. The author is professor of physics at Mount Holyoke College.

CANTAROW, ABRAHAM AND SCHEPARTZ, BERNARD. *Biochemistry.* Philadelphia: W. B. Saunders Company, 1954. 848 P. $11.00.

This is a most comprehensive text designed primarily to meet the needs of first-year medical students. The book would also serve excellently as a general reference for students of biochemistry, food chemistry, and physiology.

HARROW, BENJAMIN AND MAZUR, ABRAHAM. *Textbook of Biochemistry.* Philadelphia: W. B. Saunders Company, 1954. 563 P.

This is the sixth edition of a college textbook first published in 1938. The numerous editions attest to the very rapid developments in the field of biochemistry. This edition brings all textual material up-to-date and a new chapter on the metabolism of nucleoproteins has been added and a number of others enlarged.

SYMPOSIUM. *Staff Relations in School Administration.* Washington, D. C.: American Association of School Administrators, National Education Association, 1955. 470 P. $5.00.

This is the thirty-third yearbook of the American Association of School Administrators prepared by a special committee. The commission believes that school administration should be a

cooperative affair—*democratic* as opposed to the older concept of *control based on power, status, and authority.* The administrator should be highly skilled in the art of managing and working with all kinds of people—his administrative and supervisory personnel, classroom teachers, students, parents, and other citizens who live in the community.

How to administer a school system along democratic lines and at the same time maintain order and efficiency is a question that continues to baffle many school administrators. This challenging yearbook attempts to show how this may be done. Teachers as well as administrators should receive much value from a study of this book. The book concludes with a state-by-state roster of members.

WILLIER, BENJAMIN H., WEISS, PAUL A., AND HAMBURGER, VIKTOR. *Analysis of Development.* Philadelphia: W. B. Saunders Company, 1955. 735 P. $15.00.

Twenty-five prominent biologists contributed to this quite comprehensive treatise on a modern synthesis of the knowledge of the principles and mechanisms of animal development. Extensive references and numerous illustrations (nearly 250) are an important part of this large-paged, two column-paged book. As a resource and reference book in embryology, it will be an important book in its field for many years to come. It would serve excellently as a major text for an advanced course in its field.

MANDELKER, JACOB. *Matter, Energy and Mechanics.* New York (15 East 40th Street): Philosophical Library, 1954. 73 P. $3.75.

*Matter, Energy, and Mechanics* is based on the energy concept of matter—$MC^2$. It unifies and extends relativity mechanics by introducing a new kinetic energy formula. This new formula follows from the fact that the motion of a body whose mass increases with velocity is equivalent to *motion with resistance.* The book is quite technical and not readily readable by the average layman.

WHITTAKER, SIR EDMOND. *A History of the Theories of Aether and Electricity.* New York (15 East 40th Street): Philosophical Library, 1954. 319 P. $8.75.

This is a technical book describing some of the modern theories of physics during the period 1900–1926. Included are the Quantum Theory, General Relativity, Matrix Mechanics, and Wave Mechanics. The author is a professor in Trinity College, Cambridge, England.

EDWARDS, JOSEPH. *A Treatise on the Integral Calculus,* Volumes I and II. New York: Chelsea Publishing Company, 1954. 907 P. 980 P. $14.50 each.

This book is one of the most comprehensive treatments of the calculus available. The first edition appeared in 1921. The book should be well received by college teachers of mathematics and students interested in calculus. The author is principal of Queen's College, London, England.

LEVI, HOWARD. *Elements of Algebra.* New York: Chelsea Publishing Company, 1954. 160 P. $3.50.

This book is the text for a one-semester three-point mathematics course given in the School of General Studies of Columbia University. Over 2000 students have taken the course in the last three years. The text presupposes no previous work in algebra. It is also markedly different from the usual college text in algebra.

BABOR, JOSEPH A. AND KREMER, CHESTER B. *How To Solve Problems In General Chemistry.* New York: Thomas Y. Crowell Company, 1954. 152 P.

The major concept of this book is that students can be taught how to solve chemical problems with a minimum of guidance from the instructor. The book is designed for use regardless of what textbook is being used as the main text. All of the usual types of problems found in beginning college chemistry courses are included.

KITTSLEY, SCOTT L., *Physical Chemistry.* New York (105 Fifth Avenue): Barnes & Noble, Inc., 1955. 209 P. $1.50.

This is one of the well known College Outline series so popular with college students. It presents the essentials of the introductory course in physical chemistry, including review questions and problems with answers.

WEICHERT, CHARLES K. *Representative Chordates.* New York (330 West 42nd Street): McGraw-Hill Book Company, 1954. 204 P. $3.50.

This is a laboratory manual for use in one-semester courses in Comparative Anatomy of Vertebrates. Anatomy of the marine lamprey, the spiny dogfish, the mudpuppy, and the cat are described in detail. Complete instructions for dissection are given.

WATT, GEORGE W. AND HATCH, LEWIS F. *The Science of Chemistry.* New York: McGraw-Hill Book Company, 1954. 546 P. $5.50.

This is the second edition of a College text first published in 1949. It is designed for students in nontechnical curricula. It gives quite complete coverage of all material necessary for a basic understanding of chemical science and technology. The organization is more descriptive than theoretical. It would seem to be a very good textbook for the non-major chemistry student.

WALLACE, GEORGE J. *An Introduction to Ornithology.* New York (60 Fifth Avenue): The Macmillan Company, 1955. 443 P. $6.00.

This is an introductory college textbook in ornithology. It covers the whole field of ornithology rather than certain aspects as do so many books in this field. It is designed for student and teacher use. While relatively nontechnical, it also uses an academic approach to all phases of the subject.

The book is most readable and is supplemented by 180 photographs and illustrations. Well selected references are found at the end of each chapter.

Teachers of biology, general science, and conservation as well as elementary school teachers will find this an unusually good reference and resource book on nearly all aspects of bird life.

Dr. Wallace is Professor of Zoology at Michigan State College, East Lansing, Michigan.

LAWRENCE, GEORGE H. M. *An Introduction to Plant Taxonomy.* New York (60 Fifth Avenue): The Macmillan Company, 1955. 179 P. $3.25.

Taxonomy is a science that treats of the identification, nomenclature, and classification of objects. When concerned with plants, it is often called systematic botany. This book is concerned with ferns, conifers, and other gymnosperms, and the flowering plants.

The book is intended for the adult botanist and the student of local flora at the college level. It is an excellent reference for the secondary biology teacher, or as a college text in systematic botany. The author is Director of the Bailey Hortorium at Cornell University.

YOUMANS, W. B. *Human Physiology.* New York: The Macmillan Company, 1954. 418 P. $6.00.

Scientific method is emphasized in this college text which stresses the fact that the human body is wonderfully made as one mechanism after another of obvious "survival value" is studied. Part I considers general principles; Part II deals with muscle, nerve and reflex action; Part III discusses blood and circulation; Part IV respiration; Part V digestion; Part VI nutrition, metabolism, and excretions; Part VII central nervous system and senses; and Part VIII endocrine glands and reproduction.

The author, W. B. Youman, is Professor of Physiology at the University of Wisconsin.

BRENEMAN, W. R. *Animal Form and Functions.* Boston (Statler Building): Ginn and Company, 1954. 488 P. $6.00.

*Animal Form and Functions* is an introductory textbook in college zoology. Animals are presented as dynamic, energetic, and intriguing creatures rather than inert, colorless specimens transfixed by pins or submerged in alcohol. The text is well written, characterized by its brevity, clarity, and minimum of scientific terms. The book would serve excellently as a resource book for secondary teachers. The author, Dr. Breneman, is professor of zoology at Indiana University.

CLARKE, GEORGE L. *Elements of Ecology.* New York (440 Fourth Avenue): John Wiley and Sons, Inc., 1954. 534 P. $7.50.

*Elements of Ecology* presents a comprehensive overview of the fundamentals of ecology—stressing the unity of science. The book deals with the interrelationships of plants and animals —aquatic and terrestrial. Treatment proceeds from the simple to the more complex, but the terminology is kept as simple as possible. Something like 200 illustrations, graphs, diagrams, and photographs supplement the textual material. Secondary science teachers will find this a very good reference or supplementary book.

HEADQUARTERS STAFF OF THE AMERICAN RADIO RELAY LEAGUE. *The Radio Amateur's Handbook.* West Hartford, Connecticut: American Radio Relay League, 1955. 768 P. $3.00.

This is the thirty-second edition of the internationally recognized, universally consulted, all-purpose volume on radio. The material is completely up to date and covers practically every aspect of radio communication—from the very simple to the quite complex. Every amateur radio communication enthusiast always wants a copy of the new Handbook.

HOLMYARD, E. J. *Outlines of Organic Chemistry.* New York (103 Park Avenue): St. Martins Press, Inc., 1954. 492 P.

This is the third edition of an English textbook in organic chemistry. In literary style and treatment, the book is quite different from American textbooks. The content does not vary so much from that covered in American texts.

VAN DER ZIEL, A. *Noise.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1954. 450 P. $7.75.

This is a comprehensive advanced practical treatment of important noise problems. The author is professor of electrical engineering at the University of Minnesota.

BILLINGS, MARLAND P. *Structural Geology.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1954. 514 P. $6.95.

This is the second edition of a college textbook first published in 1942. The text places emphasis upon the principles of structural geology or tectonics—a study of the architecture of the

earth in so far as it is determined by earth movements. The book is well written and well illustrated. There are a total of some 380 illustrations plus some 20 plates. Thirteen laboratory exercises are found at the end of the book. Dr. Billings is professor of geology at Harvard University.

ARNOLD, J. N. *The Slide Rule.* New York (70 Fifth Avenue); Prentice-Hall, Inc., 1954. 206 P. $4.50.

All types of slide rules are described and discussed in down-to-earth language. The reader is told exactly how to use a slide rule and to get a high degree of accuracy. Concrete examples of problems from the fields of Business, Finance, Statistics, Chemistry, Physics, and Engineering are included. There are numerous, clear-cut illustrations. Answers to problems are supplied in the appendix.

LEVITT, JACOB. *Plant Physiology.* New York: Prentice-Hall, Inc., 1954. 172 P.

This college textbook is intended to cover a one-semester course in plant physiology. Subject matter has been confined, in general, to the higher plants. There are a wealth of illustrations.

KHARSCH, M. S. AND REINMUTH, OTTO. *Grignard Reactions of Non-metallic Substances.* New York (70 Fifth Avenue): Prentice-Hall, Inc. 1954. 1384 P. $15.00.

In the preface, the authors say that it is almost true that "he who knows and understands Grignard reactions has a fair grasp of organic chemistry, for most fundamental processes have prototypes or analogs observable in Grignard reactions." This most comprehensive treatment of Grignard reactions will be of inestimable value to students and teachers of organic chemistry for many years to come. Admittedly much material even in this comprehensive treatment has been condensed, referred to very briefly, or even omitted entirely. The authors are professors of chemistry at the University of Chicago.

HODGMAN, CHARLES D. *Handbook of Chemistry and Physics.* Cleveland, Ohio (2310 Superior Avenue N. E.): Chemical Rubber Publishing Company, 1954. 3173 P. $8.50.

This is the thirty-sixth edition of *the* handbook of physicists, chemists and mathematicians. Most users agree that no other handbook is its superior or even approaches it in coverage and usefulness, regardless of price. As a reference handbook, it is unexcelled. It contains the latest and most reliable data possible. Mathematical tables comprise 352 pages, followed by nearly 1200 pages of properties and physical constants, nearly 250 pages of general chemical tables, 250 pages on specific gravity and properties of matter, the same on heat, 150 pages on electricity and magnetism, 300 pages on light, 150 pages on quantities and units, and the rest on miscellaneous data. The book is printed on India paper, with an attractive brown cover.

TRYON, JR. ROLLA M. *The Ferns and Fern Allies of Minnesota.* Minneapolis, Minnesota: University of Minnesota Press, 1954. 166 P. $2.75.

This book comprehensively discusses the ferns and fern allies of Minnesota. There are 207 illustrations and 85 maps showing distribution of the various species within the state of Minnesota.

High school and college teachers and students of botany will find this an unusually fine text or reference book. It will serve as a useful and authoritative guide for nature study groups. The information is not only valid for Minnesota but also, generally speaking, for Iowa, Wisconsin, Nebraska, the Dakotas, and Manitoba in adjoining Canada.

KING, WENDALL B., SLABAUGH, W. H., SPLITTGERBER, GEO. H., AND FREY, PAUL R. *Laboratory Manual for College Chemistry.* New York (70 Fifth Avenue): Prentice-Hall, Inc. 1953. 252 P.

This loose-leaf chemistry laboratory manual is designed to be used primarily with the text *College Chemistry* by Paul R. Frey. The experiments are designed to develop proper laboratory techniques and a better understanding of the fundamentals of chemistry.

OWEN, D. R. G. *Scientism, Man, and Religion.* Philadelphia (Witherspoon Building): The Westminster Press, 1952. 208 P. $3.50.

Scientism is a slavish worship of science and with many has become a religion in the same sense as Christianity. Science has become potentially the source of the greatest material blessings the world has ever known. It has dissipated the clouds of ignorance and superstition; released men from bondage to unknown and coercive forces, and made it possible for them to become masters of their own world—"Science alone gives truth and this truth is absolute—matter is the ultimate reality all behavior is determined by forces beyond the control of the individual and cannot be scientifically determined."

The philosophies of Hobbes, Comte, Marx, Rousseau, and Freud led to naturalistic scientism in Germany and its offspring Nazi barbarism to the Communist totalitarianism of Russia, and the empirical scientism of the West.

The goal of Marxism is a wholly classless society—a society free of all class distinctions and forces—dictatorship will have to be exercised on behalf of all the people by a few men who will centralize everything. Twentieth century Com-

munism is a religion in the sense that it has its sacred scriptures, its dogmatic creed, its promise for the future and its way of life.

Rousseauian and Freudian philosophies led to the barbarism of the Nazi under Hitler with the idea of a superior race, the state is everything, patriotism is the highest of virtue. Thus the Germans became obsessed with the idea that their's was the master race and anything or practice contributing to that end was justified and right. Nor was or is Western culture free from taint for it has made of science a religion called scientism.

Christianity offers modern man a way of escape from final destruction by scientism. Man has a free choice to make. What will it be?

It seems to the reviewer that the author is far more pessimistic than conditions may warrant. That grave dangers from the cult of scientism do exist in Western culutre is admitted. But the development and growth of scientism as a religion is within the habits and thoughts of the scientists themselves—living and dead. The author gives no credit and more or less glibly omits the fact that many scientists are truly religious men and that they would be the first to deny science has all the answers, that it wants to or can set up its own system of religion. These scientists anti-scientism men form a goodly group of distinguished men—men such as the Comptons, Millikan, Mather, and others. Not a single mention is made of them.

However, the author writes interestingly, challengingly, even penetratingly. It is a valuable contribution to thinking in the scientific and religious field. Dr. Owen is Associate Professor of Ethics and Philosophy at Trinity College and Lecturer in Philosophy of Religion at Wycliffe College, Toronto, Canada.

GHEERBRANT, ALAIN. *Journey to the Far Amazon.* New York: Simon and Schuster, 1954. 353 P. $5.00.

*Journey to the Far Amazon* has been widely acclaimed by critics in this country and abroad. It is quite reminiscent of the earlier *Green Hell.* It is the story of the journey of three Frenchmen and a Colombian, all under thirty, who crossed from Venezuela to Brazil across the famous Sierra Parima mountains. It was a hazardous voyage, covering thousands of miles of the Orinoco and the Amazon in Indian dugout canoes. The journey began in 1948 and ended in July, 1950. They were the first white men to evèr cross from the Orinoco to the Amazon over the Sierra Parima mountains.

This is the story of a thrilling adventure, more gripping than fiction could possibly be. The book will rank as one of the great exploration stories of all time. The expedition brought back much valuable anthropological material (records and photographs) although much valuable material was lost in capsizing canoes. The four men lived with many different Indian groups including the feared Guaharibos, who are about the most, if not the most, primitive groups of people found on earth today. It would be difficult to imagine a group of people that could be more primitive and still be called human. They fortunately went through the country of the fierce Kaserapis without loss of life.

Altogether, this is about as fine a story of adventure as one is likely to run across. It will be an important book for many years to come. Truly this is a strange globe on which we live. We still have so much to learn about its life and its inhabitants. This book is a most valuable scientific contribution. When read, you'll never forget about the Stone Age savages of the Amazon's green hell.

*Rotating Electrical Machinery.* Vincennes, Indiana (1102 Shelby Street): Universal Scientific Company, 1954. 256 P. $3.50.

*Rotating Electrical Machinery* is designed for use in high school classes for use by instructors with little technical training to teach AC and DC machinery. Only elementary mathematics are used and nothing is left to guesswork. More than 300 illustrations (more space is devoted to pictures than to text) guide both student and teacher at every point. Twenty-five different operating machines are described. All types of motors and generators are discussed. The student builds assemblies that perform exactly like commercial machines. Assembly kits are available from the Universal Scientific Company.

*Bibliography of Material On Animal Experimentation.* Chicago (951 East 58th Street): Illinois Society for Medical Research, 1954. 8 P. Free.

This is a selective bibliography listing articles relating to animal experimentation. It should be of interest primarily to teachers of biology.

WAGLEY, CHARLES. *Amazon Town.* New York: The Macmillan Company, 1953. 305 P. $5.00.

*Amazon Town* is a study of man in the tropics. It is a penetrating, on-the-scene study of a backward area in the Amazon valley fictional town of Ita. The names of the towns and the people are fictitious but otherwise facts, descriptions, region, people are real. Dr. Wagley, an anthropology professor at Columbia University, and his wife spent several months research under the auspices of U.N.E.S.C.O. collecting data. The group which he headed rented a house in Ita where they lived and worked. They took their meals in the home of a local merchant. They visited with people in their homes who returned their visits. They attended parties, festivals, dances, and as many community activities as possible. They attempted to enter into the real spirit and activities of the community.

The people of Ita are primarily of Portuguese descent and Catholic in religious belief. The people are miserably poor by American stand-

ards and even in many ways by Brazilian standards. Economic standards, social standards, health conditions, and so on seem almost unbelievable. Ita is situated on the Amazon River in the rubber country where the gathering of latex, nuts and a few forest products are the main occupations in addition to the local agriculture which very inadequately supplies part of the very meager diet as judged by American standards. Fish and game animals supplement to some extent the main article of diet which is manioc or cassava. This root crop grows well in a variety of soils in varying amounts of rainfall and resists insects and disease. It can be used in a variety of ways, mainly in flour. It is an exhaustive crop and about every third year must be planted in a new area.

The author describes in detail the work carried on by the people, their social relations, family affairs, health conditions, play, recreation, religious activities, their superstitions, and so on. Although of unbelievable low standards as compared to even the worst in the United States—whether we consider the primitive agriculture, health conditions and practices, food, clothing, recreation, yet the people are not unhappy but enjoy their work, play, and place of habitat. The introduction of a health officer and some applications of science had an immediate bettering effect. Tradition and ignorance, social conditions and not climate or lack of natural resources have made these people a backward group. These conditions can, and will be, improved. Man can live and live well in the tropics when the advantages of science and technical knowledge are used.

This is a most enjoyable book to read and portrays conditions as they exist today in the Amazon with a glimpse into the vista that can be a better tomorrow.

COLLOCOTT, T. C. AND THORNE, J. O. (Editors). *The Macmillan World Gazetteer and Geographical Dictionary.* New York (60 Fifth Avenue): The Macmillan Company, 1955. 792 P. $6.95.

This is a geographical dictionary which locates, identifies, and describes every place which is likely to have significance for an English-speaking inhabitant of the globe. From A to Z, the Gazetteer covers the continents of the earth and every country in them; the world's historical cities; the important cities and towns; oceans, rivers, lakes, mountains; and climates, currents, winds, volcanoes, and so on.

Detailed information is given in most instances —physical structure, administrative and economic setup, size, location, population, culture, history, and so on.

Places and features are listed alphabetically. Pronunciations are indicated by an informal, uncomplicated phonetic system.

This is a reference book that many persons will find most useful—teachers, writers, travelers, businessmen, and readers in general.

BIRDSALL, G. W. (Editor), BRENNAN, B. E. AND PYLES, J. H. *The Aluminium Data Book.* Louisville, Kentucky (2500 South Third Street): Reynolds Metals Company, 1954. 218 P. $1.00.

This book may be obtained free upon request by using company letterhead if person requesting is an engineer, designer, technical man, or instructor.

The book has been prepared by authorities and includes the latest and most reliable informations now available. The bock discusses wrought aluminium alloys, casting alloys, physical and chemical properties, and atomic and radioactive properties. Much data are summarized in numerous supplementary tables.

THAYER, H. S. (Editor). *Newton's Philosophy of Nature.* New York: Hafner Publishing Company, 1953. 207 P. $1.15.

This volume consists of selections from the writings of Sir Isaac Newton. The selections are divided into four major parts: I. The Methods of Natural Philosophy (Rules of Reasoning in Philosophy, On Hypotheses, and The Experimental Method), II Fundamental Principles of Natural Philosophy (Newton's Preface to the First Edition of the *Principia,* Definitions and Scholium, Axioms or the Laws of Motion, The Motions of Bodies), III God and Natural Philosophy (General Scholium, God and Gravity, On Creation, and On Universal Design), IV. Questions of Natural Philosophy (The New Theory About Light and Colors, On the Science of Colors, Hypothesis Touching on the Theory of Light and Colors, Perception, and On Gravity.) V. Questions from the "Optics." Relatively free from mathematics, this book makes available many of the writings of Newton not always available to students of science, and may readily be read by laymen including high school students. This book would make an excellent addition to the high school science library.

WILLIAMS, ARTHUR. *Recreation for the Aging.* New York (291 Broadway): Association Press, 1953. 192 P. $3.00.

*Recreation for the Aging* was prepared for the National Recreation Association. It presents a composite picture of successful programs in action throughout the country. Time often hangs heavy on the hands of those retired and the aging. Recreation activity is one of the solutions for this excess leisure time. Such programs need to stress informality, fun, and have a social atmosphere.

This book details the qualities needed for effective leadership, gives practical suggestions for getting groups organized. Activities described include: arts and crafts, camping and day camping, hobbies and hobby shows, music and drama, service and educational programs, social activi-

ties, and spectator activities. This is a fine book for those interested in recreation activities for the retired—either personally or in directing group activities.

GAMOW, GEORGE. *The Moon.* New York (20 E. 70th Street): Henry Schuman, Inc. 1954. 118 P. $2.50.

As the earth's nearest neighbor, the moon has always been of great interest to the earth's inhabitants. In this book one of the world's greatest astronomers presents many interesting facts about the moon—eclipses, phases, surface, life possibilities, origin, and man's possibility of eventually reaching the moon by means of a rocket.

Dr. George Gamow arrived in the United States in 1934 and since that time has been a professor at George Washington University. He is author of *The Birth and Death of the Sun, Biography of the Earth,* and *Creation of the Universe.*

TRIPP, TYRUS T., CASSENS, ALWIN, ET AL. *Low Cost Homes.* New York (215 East 37th Street): Sterling Publishing Company, Inc. 1953. 143 P. $3.95.

The thirty contemporary homes presented in this book were selected and approved by the staff of *Today's Woman Magazine.* Each house has been constructed and lived in. All are in the low cost range probably averaging about $9,000 with a low of $4500 and a high of $18,000. Each house and usually two or more rooms are presented by photographs. There is descriptive material and two floorplan drawings. For each house is included also the basic specifications, plot size, and probable cost of construction. Many practical, desirable and unique ideas are shown. A unique feature of the book is an illustrated glossary of building terms. All types of homes are represented from ranch type, Cape Cod Colonials, Modern Californians, and so on. A set of blue-prints costing $10.00 is available for each house represented. Those persons contemplating building a house will find this an excellent book to consult before definite building plans are made.

TURNER, D. M. *The Book of Scientific Discovery.* New York (105 E. 24th Street): Frederick Ungar Publishing Company, 1953. 285 P. $3.95.

This is a revised edition of a book first published in 1933. It is intended to give young people an introduction to the principal scientific facts and discoveries known to man. The great advances made in science during the last twenty years are recognized in this new edition. The emphasis is on how science has aided human welfare. The treatment is somewhat historical in nature, beginning with science in the very earliest times, followed by the middle ages, and down to the present. All phases of science are considered in this somewhat comprehensive overview. There are some 30 photographs and 40 illustrations.

Dr. Turner is a Senior Lecturer in Maria Grey Training College in London, England. The account is most readable and would make an excellent addition to the high school science library.

DANTZIG, TOBIAS. *Henri Poincaré: Critic of Crisis.* New York (597 Fifth Avenue): Charles Scribner's Sons, 1954. 149 P. $3.00.

The above title is one of the *Scribners Twentieth Century Library* books on great thinkers of the last century. The year 1954 is the hundredth anniversary of the birth of Henri Poincaré. He died in 1912. Poincaré is now recognized as one of the intellectual giants of the modern world in science and mathematics.

This book presents certain essays from the publications of Poincaré: On Rigid Standards, On Rhythm and Duration, On Clocks and Systems, Straight and Steady, In Quest of the Absolute, Figures Do Not Lie, The Infinite, Science and Reality, and so on.

The following is a quotation from Poincaré's *The Value of Science:*

Only Science and Art make civilization worthwhile. One may be startled by the formula: *Science for the Sake of Science,* and yet, it is worth as much as *Life for Life's Sake,* if life is but misery; and even as *Happiness for Happiness Sake,* unless one believes that all pleasures are the same in quality, the goal of civilization is to furnish alcohol to all who love to drink.

PETTERSSON, HANS. *Westward Ho with the Albatross.* New York (300 Fourth Avenue): E. P. Dutton & Company, Inc., 1953. 218 P. $4.00.

This is the story of the 1947–48 Swedish Deep-Sea Expedition under the leadership of Professor Hans Pettersson, Head of the Institute of Oceanography at the University of Goteborg, Sweden. The expedition was financed and controlled privately. Explorations were confined to the areas between 30° North and 30° South Latitude. The Albatross was especially fitted out for deep-sea observations and laboratory work. The journey covered fifteen months in time and 45,000 nautical miles in distance, crossing the equator 18 times and covering the Atlantic, Pacific and Indian Oceans, and the Mediterranean Sea.

One of the especial tasks of the expedition was to obtain core samplings of the sediments of the ocean-floor. This they did in amounts and depths far surpassing anything done previously. They obtained samples up to 65 feet in length (as contrasted with the usual 2 feet of previous expeditions) of sedimentation dating back more than 3,000,000 years. It will take scientists many years to completely analyze these samples and report conclusions. The expedition also made numerous depth soundings and obtained

many samples of deep-sea-marine-life; some life obtained at depths as low as 4,000 fathoms. Biological samples were also obtained from land areas visited.

This is as much a travelogue of the places visited and persons met as it is a description of the work aboard the Albatross.

Much important information, mostly to be reported in the future, was obtained. A few results reported include: Evidence to support the belief that analysis of Nickel content of deep-sea sediments indicate that meteor falls may be 1000 times greater than figures previously estimated by astronomers. Seemingly there was a rapid fall in the temperatures of the world about 117,000 B.C., a maximum temperature 40,000 years later, another minimum about 68,000 B.C.; another maximum about 43,000 B. C. followed by another minimum about 23,000 B. C. followed by the last maximum between 7,000 and 3,000 B. C.

This is a most interesting book to read and is highly recommended for the high school library.

PALMER, RALPH S. *The Mammal Guide.* New York: (575 Madison Avenue): Doubleday and Company, Inc., 1954. 384 P. $4.95.

This is one of Doubleday's popular *Pocket Nature Guide* series. Written expressly for the layman *The Mammal Guide* deals fully with identification, habitat, range, reproduction characteristics, behavior patterns, and conservation. Both common and scientific names are given. Maps are used to indicate range areas of the various mammals.

This is said to be the most complete and fully illustrated guide to the mammals ever published. There are 250 figures, illustrating 182 species, in full color, 37 live drawings.

High school biology and elementary school teachers will find this guide excellent for identification and a reference book. It is highly recommended for the science book shelf. The author, Dr. Palmer is State Zoologist in the New York State Museum and State Science Service at Albany.

KITAY, WILLIAM. *New Facts About Bursitis.* New York (432 Fourth Avenue): Thomas Y. Crowell Company, 1953. 242 P. $3.50.

Bursitis is a long misunderstood and neglected disease, only recognized about 20 years ago. Today there are more than 2½ million bursitis sufferers in this country alone. It seemingly is on the increase and to quite an extent is an occupational disease. Two types are recognized: acute and chronic.

The author discusses the history of bursitis, the kinds, the causes, the symptoms, medical, and home treatment. Medical treatment includes deep x-ray therapy, diathermy, massage, surgery, and wonder drugs. Thirteen diseases that are bursitis are described. It is said that only patients suffering from bursitis can appreciate the internal pain involved. Recovery is often partially mental. There is a chapter on twenty-things to remember and another chapter on practical home care.

The book is interestingly written and should be of great interest and value not only to bursitis sufferers themselves but to their relatives and friends as well as others who desire an authoritative discussion on bursitis.

GELDARD, FRANK A. *The Human Senses.* New York: John Wiley and Sons, Inc., 1953. 365 P. $5.00.

This is a unique book in that it is the first book to describe man's senses from the psychological-physiological point of view. Each of the sense channels is treated from the standpoint of physics of stimuli and the anatomy and physiology of the sense organ before the discussion on the phenomena of the sense itself. Sight, hearing, feeling, smelling, and taste are unique organic operations tuned to the outside world.

There is an introductory chapter discussing the role of senses in human life. There are also chapters dealing with pressure, pain, and temperature sensitivities. There are more than 100 illustrations.

This is an excellent book for the high school biology and physics teacher as well as college teachers of general courses in biology and the physical sciences.

ALLEN, SHIRLEY W. *Conserving Natural Resources.* New York (330 West 42nd Street): McGraw-Hill Book Company, 1955. 347 P. $5.50.

This is a college textbook covering the entire field of natural resources, including mineral resources. The author discusses the nature of each group of resources and its significance to the individual and national economy. The practices which lead to depletion of our natural resources and those which foster their fair distribution and conservation are analyzed.

The book would serve as an excellent reference for elementary school teachers and higher level teachers, too, such as teachers of general science, biology, and conservation. The author is Professor Emeritus in the School of Natural Resources of the University of Michigan.

KLINE, MORRIS. *Mathematics in Western Culture.* New York: Oxford University Press, 1953. 484 P. $7.50.

*Mathematics in Western Culture* is a major contribution in the field of publications for the layman. Undoubtedly it is the finest book of its kind that has been published and will become a classic as the years go by. The book is equally interesting to science teachers as mathematics teachers and in many instances even more so.

The book enumerates the major contributions mathematics has made to the thinking and practices of men both in the past and in the present. Mathematics in a real sense is as much a part of the culture of modern man as is science. In fact both mathematics and science are intimately interwoven.

Naturally the approach used in this book is historical, showing how each branch of mathematics developed in each contributing country. Science could not have made the advances it has without its mathematical foundations. Mathematics has profoundly influenced the thinking and philosophy of man—even in religious matters. Quantitative thinking rather than merely qualitative thinking was made possible by use of mathematics. Man's search for truth has its roots in the qualitative contributions of mathematics.

Altogether *Mathematics in Western Culture* is one of the most outstanding publications in the last several years. Undoubtedly it will become a classic in the field of books in mathematics written for the layman. It will takes its place along with writings of such popularizers of mathematics as Bell, Smith, Coolidge, Kramer, Steinhaus, and others. The literary style of the author is most readable. There is a series of 27 plates showing the place of mathematics in the arts. Both teachers of science and mathematics will find this an unusually fine book—truly a classic in its field.

SOKOLOFF, BORIS. *Cancer.* New York (23 East 26th Street): The Devin-Adair Company, 1953. 243 P. $3.75.

To a layman, cancer is the most dreadful of all diseases. More than in any other disease, infectious or chronic, the public is conscious of the potential danger, of the often fatal outcome. In spite of all of the educational campaigns, it remains as mysterious and fearful to the layman as was the plague to the man of the Middle Ages. This confusion is partially justified. So much written about cancer or discussed on the radio and television is contradictory—often overly optimistic or even pessimistic. Cancer to the medical profession is a puzzling and a disturbing problem.

Doctors and research men today do know much about cancer—to some degree what it is, how it develops and grows, how it may be caused, how its growth may be inherited, and how it may be cured.

The term "cancer" is applied to a number of malignant diseases that differ as much as leukemia and carcinoma. These different kinds of cancer differ in origin and in course of development. Pathologically the growths are alike. Some grow very slowly, some rapidly. A majority can be cured if detected early enough and promptly removed.

Cancer may originate in numerous, sometimes seemingly insignificant causes. A bruise on the skin or leg, a ragged or decayed tooth, a mole, an irritation such as a pipe, certain chemicals as in coal tars and the presently suspect cigarette, deficient nutrition, certain vitamin deficiencies, hormone secretions, metabolism changes, viruses, and so on. Probably cancer results from a variety of causes. Some of these seemed to be definitely known. Cancer is not contagious nor inherited directly. If inheritance is a factor at all it would seem to be indirectly through susceptibility. Hodgkin's disease if classified as cancer may be an exception to this general statement.

Fat people are more prone to cancer than thin people. A diet rich in fat seems to favor tumor formation. The same is true of carbohydrates. A high-protein diet seems to inhibit cancer tendencies. However once started, cancer is not inhibited by any diet. All types of irritations should be eliminated.

The author traces all of the types of cancer research so far carried out—from the use of diets, hormones, chemicals, radioactive substances, antimetabolites, bacterial toxins, x-rays, antibiotics, and other chemicals.

*Cancer* is a book especially for the layman. It is non-technical in literary style, and rather complete. Dr. Sokoloff is Director of Bio-Research Laboratory, Florida Southern College, and is himself engaged in certain aspects of cancer research. The situation is most hopeful but intensive and extensive research is needed along many lines. The ultimate goal is not only to find the cause of cancer, its cure, but even more important, a preventive either for after it starts to develop, or more important before it starts.

HUGHES, G. BERNARD. *Living Crafts.* New York (15 East 40th Street): Philosophical Library, 1954. 192 P. $4.75.

While machines now do most of our work, hand craftsmanship still has an important place and in many instances produces a superior product. The finest paper, the best glass, the finest cloth, the most artistic metals, and so on, are still the products of skilled craftsmen. This book with descriptive material and photographs tells about many modern crafts. A skilled, highly trained workman can still compete with the best machines.

Among crafts described are: the clay tobacco pipe-maker, the gold-beater, the silversmith, the pewterer, the wire-drawer, the textile printer, the carpet-maker, the wood-turner, the cooper, the basket-maker, the charcoal-burner, the paper-maker, the parchment-maker, the horner, the fireworks maker, the glass-blower, and the soap-boiler.

The approach to each craft included historical material of much interest, making this a most interesting book.

LARSEN, EGON. *An American in Europe.* New York: The Philosophical Library. 1953. 224 P. $4.75.

*An American in Europe* is a story of the life of Benjamin Thompson, Count Rumford. And what a life he had! His life was one of those rare reversals—an American born in Massachusetts who became a great scientist in Europe. More often European-born persons have become great scientists in America.

Count Rumford was born March 26, 1753 at North Woburn near Boston. A British-sympathizer and actually a spy, during the American Revolution, he escaped in a British ship from Boston Harbor, and went to England. There he became Under-Secretary in Lord North's Government. Later he became minister of War and Police in Bavaria, and a research scientist, living in France, England, and Bavaria.

He was truly a great scientist but his private life left much to be desired. His marriage to the widow of Lavoisier was one of violent turmoil, ending in divorce.

His acomplishments in science were spectacular —truly outstanding. They included the development of the modern theory of heat, a nutrition expert, the discoverer of Humphry Davy, development of the common range, the inventor of the fuel-saving, non-smoking fire place, the first social reformer to abolish beggary, the founder of Europe's first citizen's army, and so on.

Much of the material in this fine biography is based on original material, including excerpts from a number of his scientific papers.

TAYLOR, GRIFFITH (Editor). *Geography In the Twentieth Century.* New York: Philosophical Library, 1953. 661 P. $8.50.

So great was the demand for the first edition of this book published in 1951 that this revised and enlarged edition has been made available. Twenty-two authors, each of whom is a specialist in a specific area, have contributed to this volume. The growth, fields, techniques, aims, and trends of geography are stressed. The book is divided into three parts of which the first deals with the evolution of geography and its philosophical basis. Part II deals with studies of special environments and with the advances in geomorphology, meteorology, climate, soils, and regionalism. The last part considers field work, sociological and urban aspects, the function of the Geographical Society, and Geo-politics. The reviewer found a number of chapters of especial interest and unusually well done. These include *Climatic Influences* by Stephen S. Visher, *Geography in the Nineteenth Century* by G. Tatham, *The Progress of Geomorphology* by S. W. Wooldridge, *Geography and the Tropics* by Karl J. Pelzer, and *Racial Geography* by Griffith Taylor.

There are 14 plates, 56 text illustrations, and a glossary of 700 geographical terms. Altogether this is the most comprehensive up-to-date overview of the entire field of geography that has been published. Especially appreciated by geographers, lay readers will find this a fine resource of geographic information, for the most part, written in an interesting literary style.

FEARNSIDE, K., JONES, E. W., AND SHAW, E. N. *Applied Atomic Energy.* New York (15 East 40th Street): Philosophical Library, 1954. 156 P. $4.75.

In recent years the application of atomic energy to peacetime uses in the shape of radioactive isotopes is receiving considerable attention. A number of problems have been satisfactorily solved by the new techniques.

The authors provide a background knowledge of nuclear physics necessary to an understanding of the advantages in using radioactive materials. Discussed are radiography techniques and the use of isotopes in pure research, in medicine, in agriculture, in biology, and in industry. Since the authors are British scientists, more reference is made to radioactive isotopes research in Britain. The material presented is intended primarily for the layman.

WEAR, TED. *Brownie Makes the Headlines.* New York (8 West 40th Street): Julian Messner, Inc. 1953. 63 P. $1.60.

This is a *Messner Everyday Adventure Story.* It is a story for grades two and three telling how a newspaper is printed and how a story gets on the printed page. It is built around the story of Tommie and Nancy who go to a newspaper to place an ad in the Lost and Found department to find Brownie who is very much needed by her week-old puppies.

This is a recommended book for the elementary school book shelf or library. It gives step-by-step information about how a newspaper is made.

HOLLISTER, GEORGE E. AND GUNDERSON, AGNES G. *Teaching Arithmetic in Grades I and II.* Boston: D. C. Heath and Company, 1954. 168 P. $2.50.

Teachers of first and second grade will welcome this book on teaching arithmetic in the first two grades. While some attention is paid to theory, the emphasis is on what may be taught and methods of teaching it—facts, devices that may prove useful in teaching arithmetic, kinds of problems, vocabulary needed for number work, and so on. Teachers will especially appreciate the many suggested techniques, devices and materials for teaching arithmetic or numbers in the first two grades. Good teaching of arithmetic in the first two grades is essential in laying the basis for adequate understanding and the development of proper attitudes toward arithmetic in the later grades. A knowledge of arithmetic is being recognized as being increasingly more important in the atomic age into which we

are fast moving. Many primary teachers may find this the very book for which they have been looking.

FREEMAN, OTIS W. AND MARTIN, HOWARD H. (Editors). *The Pacific Northwest.* New York (440 Fourth Avenue): John Wiley and Sons, Inc., 1954. 540 P. $8.50.

*The Pacific Northwest* presents an integrated account of the economic, social, human, and physical status of the Northwest region. Content is based upon published and unpublished reports of research. Thirty specialists contributed to the content material. These specialists include geographers, geologists, metorologists and Climatologists, anthropologists, conservationists, historians, and forestry and range experts. There are numerous maps, photographs and illustrations.

This book is without question the most comprehensive, accurate book relating to the Pacific Northwest that is currently available. The authors are two of America's best known geographers. Dr. Freeman taught for many years at Eastern Washington College of Education, later as acting State Geologist for Indiana, Specialist for Geography in the U. S. Office of Education, and was President of the National Council of Geography Teachers in 1954. Dr. Martin is Professor of Geography at the University of Washington.

LONGWELL, CHESTER R. AND FLINT, RICHARD FOSTER. *Introduction to Physical Geology.* New York (440 Fourth Avenue): John Wiley and Sons, Inc., 1955. 432 P. $4.95.

Representatives of more than 140 college geology departments contributed ideas and viewpoints to the arrangement and relative emphasis of the content of this book. The presentation is lucid, utilizes a minimum of scientific terms, authoritative, accurate. There are more than 340 photographs and drawings. The authors are well known Yale professors of geology, noted for the excellence of their other geological textbooks.

Altogether, this book will serve as a fine textbook or as an excellent reference for the general science or college physical science teacher or student.

SINNOTT, EDMUND S. AND WILSON, KATHERINE S. Botany: *Principles and Problems.* New York (330 W. 42nd St.): McGraw-Hill Book Company, 1955. 528 P. $6.75.

For more than a quarter of a century, Sinnott's *Botany* has been considered an outstanding text in college botany. The reviewer used it as a student and liked it very much. This revision is so much superior to that first edition, although many of the earlier features have been retained.

This edition is completely modernized both in format, in general appearance, illustrations, two-column pages, content, and even nomenclature. The illustrations are unusually good. This is a fine textbook not only for beginners planning to major in botany, but as well for those for whom the course is terminal. At the end of each chapter is a list of unusually good questions for thought and discussion. The book would serve excellently as a general reference for high school biology and elementary science teachers, for students in general biology courses, and for the better high school students.

HARROW, BENJAMIN; BOREK, ERNEST; MAZUR, ABRAHAM; STONE, GILBERT C. H.; AND WAGREICH, HARRY. *Laboratory Manual of Biochemistry.* Philadelphia: W. B. Saunders Company, 1955.

This is the fourth edition of a college laboratory manual designed to accompany the authors' text *Textbook of Biochemistry.* The manual is for a two-semester course in biochemistry. Directions are very specific and the experiments have tested and retested many times.